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ABSTRACT

Developed to help students of grades five through eight attain an understanding of the natural environment, this booklet provides investigations which focus on humanity's relationship with the environment. While some of the experiments are adaptable to the classroom, many of the activities are more appropriately implemented out-of-doors on the school yard or at an outdoor educational facility. Nineteen investigations are offered on the topics of: (1) air; (2) water; (3) transportation; (4) soil; (5) plants; and (6) animals/insects. Each activity consists of student sheets and a teacher's guide. Teacher's materials include suggestions for classroom management, instructional procedures, classroom discussion, and activity extensions. Specific mathematics skills and science processes are also identified for each activity. (ML)

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# OUR WONDERFUL WORLD

## Solutions for MATH + SCIENCE

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**BOOK 7**

 **ENVIRONMENTAL STUDIES**

# OUR WONDERFUL WORLD

## *Solutions for MATH + SCIENCE*


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# Project AIMS

Project AIMS has as its purpose the integration of subject matter in K-9. Such integration enriches and makes learning meaningful and holistic. Project AIMS began as a program to integrate mathematics and science, but has since developed to also include language arts, social studies, and other disciplines. The acronym "AIMS" stands for "activities to integrate mathematics and science."

Project AIMS is a continuing, non-profit project of Fresno Pacific College. It had its inception in a National Science Foundation funded program to train teachers in the integration of mathematics and science. This quickly created the necessity to write instructional materials incorporating this concept. Despite the fact that thoughtful educators have long recommended this approach, very little appropriate material was available.

Currently, Project AIMS is funded solely through the sale of this developing series of books. All net proceeds from their sale flow into a trust fund administered by Fresno Pacific College. The use of this fund is restricted to the support of continued research and development, partial scholarships for classroom teachers who participate in the writing and field testing teams, and the publication of the books.

Two writing teams have completed their work. The first consisted of seventy-five teachers in grades 5-9 who met over a period of eighteen months. The second involved thirty-five K-4 teachers who wrote during a two-year span. In the fall of 1985 a third team of approximately fifty teachers in grades 2-9 will begin writing. In addition, over a hundred teachers have been involved in field testing newly created materials.

The rationale for this integrative thrust lies in the fact that science, mathematics, language arts, social studies, etc., are integrally interwoven in the real world outside the classroom, from which it follows that they should be similarly treated in the classroom if we are to prepare our students for life in that world. Teachers who have used Project AIMS lessons give enthusiastic endorsement to the effectiveness of this approach.

Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. The language arts provide us with powerful tools of communication. Many of the major contemporary issues involve societal issues stemming from advancements in science. It is time, therefore, that all of us in the teaching profession take seriously using a more holistic mode of transmitting knowledge to students. It is this that motivates all of us who are involved in creating or using the integrative materials of Project AIMS. We invite you to join us in this effort.

Extensive field testing of these materials confirms the following beneficial results.

1. Mathematics becomes more meaningful, hence more useful, when it is applied to situations that interest students.

2. The extent to which science is studied and understood is increased, with a significant economy of time resulting from the integration of two or more disciplines.

3. There is improved quality of learning and retention, supporting the thesis that learning which is meaningful and relevant is more effective.

4. Motivation and involvement are increased dramatically as students investigate real world situations and participate actively in the process.

We invite you to become part of this classroom teacher movement by using an integrated approach and by sharing any suggestions you may have or investigations you would recommend. Project AIMS welcomes you!

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Pieces and Patterns, A Patchwork in Math and Science

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Spring Into Math and Science
Seasoning Math and Science, Book A (Fall and Winter)
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I HEAR, AND I FORGET

I SEE, AND I REMEMBER

I DO, AND I UNDERSTAND

–Chinese Proverb

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# INTRODUCTION

The environmental studies booklet, Our Wonderful World, emphasizes investigations which explore man's relationship with his surroundings. While some of the experiments are adaptable to the classroom, many of the activities are more appropriately implemented out-of-doors on the school yard or at an outdoor educational facility.

The nineteen investigations are sequenced according to the following topic areas:

1. Air
2. Water
3. Transpiration
4. Soil
5. Plants
6. Animals/Insects

Understanding the natural environment should be an important goal of education. The writing team hopes that the contributions here will help attain that goal.



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# WHAT's in the AIR ?

I. **Topic Area**
Air Pollution

II. **Introductory Statement**
The human brain can survive without oxygen for about eight minutes. The blood (hemoglobin) which carries oxygen to the brain, actually prefers carbon monoxide (a major motor vehicle pollutant). It is a fact that the more we pollute our air, the greater the likelihood of an earlier death. This experiment enables the student to actually "see" the different pollutants in our atmosphere.

III. **Math Skills**
a. Whole number operations
b. Averaging
c. Graphing

**Science Processes**
a. Observing
b. Collecting data
c. Analyzing data

IV. **Materials** (per group)
Clear contact paper
Metric ruler
8 small lath (wood) pieces (50 cm lengths)
Graph paper
Staples, tacks, or nails
hammer
Black felt pen
Thermometer
Magnifying glass
Anemometer (optional)
Microscope (optional)

V. **Key Question**
Does the amount of solid pollutants (particles) vary within different habitats?

VI. **Background Information**
"Environmental quality", a term introduced by the National Wildlife Federation, refers to the conditions that make life possible or tolerable — or the contrary. Pollutants, all kinds, are largely products of physical and biological forces that are constantly operating on earth. Animals produce carbon dioxide; volcanoes emit sulfur dioxide; and movements of the wind constantly swirl solid particles into the air.

Air pollution is one of the most dangerous forms of pollution, for we all need air to breathe (live). Sulfur oxides, nitrogen oxides, carbon monoxide and hydrocarbons are essentially invisible to us, but they can, nevertheless, be lethal.

The greatest source of air pollution is the combustible engine (cars, trucks, etc.). The 109 million motor vehicles in the U.S. produce the following pollutants each year:

1. 66 million tons of carbon monoxide.
2. 12 million tons of hydrocarbons.
3. 6 million tons of nitrogen oxide.

This means that a total of 84 million tons of pollutants are introduced into our atmosphere each and every year. Add to this the 23 million tons of air pollution from industry and the fact that we each need 30 pounds of air each day in order to remain alive and you may have a better appreciation of the air pollution problem.

The brain cannot be deprived of oxygen for more than eight minutes without permanent brain damage. Our blood is the "truck" that brings oxygen to our brain, which it gets from our lungs, which it gets from our atmosphere. The only problem is that our blood actually prefers carbon monoxide — to the tune of 200% more — than oxygen. So, if carbon monoxide is in the lungs, the hemoglobin in the blood will absorb it, before oxygen. The consequence, of course is deadly.

It takes about 1,000 cars to produce 3 tons of carbon monoxide each day — and the number of cars is increasing each day. The U.S. alone, manufactures over 12 million new vehicles each year and approximately 6 million are scrapped each year. That gives us a net increase of over 6 million new cars each year or about 16,000 per day. Air pollution is a problem. Even the automobile industry acknowledges this. The only controversy has been as to how to prevent it and how do we "clean it up".

VII. **Procedure** (construction of frame)
1. Using the lath pieces, make frame approximately 50 cm by 50 cm.
2. Using the felt tip pen, mark the graph paper into any sample size area you wish to sample (i.e. 10 $cm^2$ sections or 1 $cm^2$ section).
3. Place the graph paper between 2 sheets of contact paper with sticky sides up so that the graph paper is securely held in place.
4. Staple (thumbtack/nail) the "contact plate" to the lath frame. Add a support. See student worksheet page 1 for illustration.
5. Select several different locations to display the plates.
6. Check the plates daily and fill out the "What's in the Air" chart. Use radio, newspaper, and T.V. for weather data.
7. Examine the amount of pollutants from 4 random squares. Use the sample grid coordinates (square) each day. Count the number of pollutants in each grid and record the average number of pollutants on the chart.
8. Results may be quantified and graphed-based on location, weather conditions, and amount of pollutants that were recorded over a period of time.

X. **Discussion**
1. Did any pattern develop?
2. Would seasons make a difference in the number of pollutants released into the air?
3. From the data in this experiment, choose one place to live and defend your position.


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# * Bottled Pollution *

I. **Topic Area**
Air pollution

II. **Introductory Statement**
"Good" air is so essential to human survival that a few minutes deprivation can result in irreparable damage to the central nervous system. Today we know of many disease germs that are carried by the air we breathe. Everyone has experienced the discomfort of breathing air containing too much smoke or a high ratio of dust particles. This experiment will enable the student to see and measure the amount of solid particles in the air.

III. **Math Skills**
a. Whole Number Operations
b. Graphing
c. Using Formulas

**Science Processes**
a. Observing
b. Collecting Data
c. Analyzing Data

IV. **Materials** (per class)
3 one-gallon, wide mouth glass jars
2 gallons of distilled water
3 three quart metal pans (or Pyrex)
1 square meter wire mesh window screening
1 meter light wire
1 balance and metric weights or masses
hot plate

V. **Key Question**
How can we measure solid particles (pollutants) in the air?

VI. **Background Information**
There are always solid particles in the air. To demonstrate this, darken a room and put on a flashlight or slide film projector. The students may readily see the solid particles in the air. A ray of sunlight may show this as well. You can shake a jacket or sweater in the beam of light and again you will see the solid particles floating in the air. Each person needs an average of thirty pounds of air each day in order to remain alive. It is estimated that the U.S. introduces about 107 million tons of pollutants in to the air each year and that amount is growing each year.

VIII. **Procedure**
1. Label the jars 1, 2, and 3. Put one liter of distilled water into each jar and clearly mark the level.
2. Cover the top of each jar with a piece of wire mesh window screening folded down over the mouth and fastened with light wire.
3. Pre-select three locations that you wish to test. Set the jars outside about 1.5 meters off the ground. Since you will need to expose the jars for 30 days, make sure that they are in a place that will not be disturbed by people or animals.
4. Check each jar from time to time, record your observations on Table 1 and add distilled water to keep the water at the level marked on the jars.
5. After the thirty days have elapsed, pour the water from jar 1 to pan 1 (make sure you mark each pan before you begin). Place the pan on a heat source such as a hot plate, and carefully evaporate the water. Repeat for jars and pans 2 and 3. Add more water from each jar to each pan until all the water has been evaporated. You may need to rinse each jar with additional distilled water until all the material collected in the jar has been transferred to its pan.
6. On Table II record the mass of the pan and the dust, and the mass of the pan. You will then subtract the mass of the pan from the mass of the pan and the dust which will result in the mass of the dust in milligrams. This is the amount of "dust" collected in thirty days per the surface area of the jars.
7. If this experiment is done during consecutive months, the students could observe some variations in number of pollutants by season.

X. **Discussion**
1. How many solid particles were in the air?
2. Does the amount of particles vary at different locations?
3. What impact might this have in choosing a place to live and work?

XI. **Extension**
An air pollution commission measures solid pollutants in tons per square mile per month. To change your results to these units, measure the inside diameter of the mouth of the jar and then find the area of the jar mouth using the following formula.

area = pi ($\pi$) times radius squared ($r^2$)
area = $3.14 \times r^2$

If the diameter of the mouth of the jar is 12cm, that means a radius of 6cm, therefore:

$$\text{area} = 3.14 \times r^2$$
$$= 3.14 \times 6^2$$
$$= 3.14 \times 36$$
$$113.04 \text{ sq. cm}$$

Use the following formula to convert to tons of "dust" per square mile per month (dust amount):

Dust amt. = mass of dust area of jar mouth X 28.6 (conversion factor)
= 15 mg ÷ 113.4 X 28.6
= 15 mg. ÷ 113.4 = .1326 X 28.6 = 3.79
= 3.79 tons of dust per square mile per month



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# WHITE RAIN

I. **Topic Area**

Temperature and volume analysis of snow.

II. **Introductory Statement**

Snow is water in a solid form. Students will examine snow to discover the temperatures at which it exists and the volume of water that it can produce.

III. **Math Skills**

a. Graphing
b. Percent
c. Ratios
d. Averaging

**Science Processes**

a. Measuring Volume & Temperature
b. Observing
c. Predicting & Estimating
d. Controlling Data
e. Applying & Generalizing

IV. **Materials**

Thermometers (calibrated below 32° F or 0° C)
Snow, refrigerator frost, or crushed ice
Calibrated containers
Candles or other heat source
Filter paper

V. **Key Question**

How much water can snow produce and at what temperature does snow melt?

VI. **Background Information**

Water exists in 3 stages: solid, liquid and gas. The form water takes is determined by the amount of energy contained by the substance. Temperature is a relative measure of the amount of energy contained within a substance. At different temperatures water exists in different states because the molecules within a substance behave differently at varying energy levels. As energy is removed from a liquid (cooling), the molecules slow down and move closer together until, at the freezing point, the molecules bond themselves into a solid structure. When energy is applied to a solid (heating), the molecules begin to move faster and farther apart until the bonds of the solid are broken and a liquid is formed. Continually adding more energy would result in the liquid evaporating to a gas. At this boiling point, the molecules of a liquid are energized enough to dispense into the air.

Water freezes at 32° F or 0° C and boils at 212° F or 100° C. Unlike most substances water expands in volume as it freezes. Consequently, a one liter block of ice would produce less than a liter of water. The stacking of snow flakes, which are themselves not solid, results in an even smaller volume of water when melted. Melted snow also produces a small amount of debris because each flake is formed around a minute particle of air pollution.

VIII. **Procedure**

1. See IX. What the Students Will Do.

IX. **What the Students Will Do**

1. Obtain a sample of snow in a clean calibrated container. Record the volume, temperature and condition (wet, dry, dirty, clean, etc.) of the snow.
2. Estimate the volume of water that the snow will produce when melted. Record the estimate.
3. Place container over a heat source.
4. Record the temperature of the snow at one minute intervals as the snow melts. Continue taking readings for 5 minutes after all the snow crystals have disappeared. Note the temperature of the sample when water first appears and when the last crystal disappears.
5. When the snow is completely melted, record the volume of the liquid.
6. Strain the sample through clean filter paper and record observations.
7. Graph the temperature versus the time.

X. **Discussion**

1. How close were the volume estimates?
2. Compute and record the percentage of error.

   Actual volume = 20 ml
   Estimated volume = 60 ml

$$\begin{array}{r} 60 \text{ ml} \\ -20 \text{ ml} \\ \hline 40 \text{ ml} \end{array}$$

$$20 \overline{)\,40.00} \quad \begin{array}{r} 2.00 \end{array}$$

   = 200% error

3. Compute and record the percentage of volume lost when the snow melted.

$$\begin{array}{rl} 100 \text{ ml} & \text{of snow} \\ -25 \text{ ml} & \text{of water} \\ \hline 75 \text{ ml} & \text{loss} \end{array}$$

$$100 \overline{)\,75.00} \quad \begin{array}{r} .75 \end{array}$$

   = 75% loss

4. Formulate and record a ratio of snow volume to water volume.

$$\begin{array}{rl} 100 \text{ ml} & \text{of snow} \\ 25 \text{ ml} & \text{of water} \end{array} \quad = 4/1 \text{ ratio}$$



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5. What was the melting point temperature of the snow? Did the temperature change at a constant rate?
6. How would the temperature have changed if the experiment had gone on indefinitely?
7. What happened to the temperature readings after most of the crystals disappeared? Why?
8. Did the type of snow affect the volume of water produced?
9. At what temperature do you think crystals would begin to form if we cooled the sample?
10. What causes snow to melt? Why does this happen?
11. How do you think hydrologists predict how much water a snow pack will produce?
12. Suppose a 10 meter deep swimming pool were filled with snow. About how many meters of water would have to be added to fill the pool when the snow melted?
13. How many milliliters of volume would be lost if 200 milliliters of snow were melted?
14. Could you make a better prediction about volume change if we repeated our experiment? Why? Try it and compute your new percentage of error.

IX. **Extension**

1. How does salt affect the melting process of snow and ice? (It speeds up the melting process.)
2. How would an ice volume/water volume ratio compare to that of snow? (The ice ratio would be smaller.)
3. Why do icebergs float? Would they float in fresh water? How much ice would be above the surface? (Ice floats in water because the ice is less dense than water. Icebergs would float in freshwater but less ice would be above the water because fresh water is less dense than salt water.)

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# WATER STILL on the HILL

I. **Topic Area**
Water condensation

II. **Introductory Statement**
The students will observe and experience the process of extracting water from the air through condensation.

III. **Math Skills**
a. Measuring
b. Charting & Recording
c. Graphing

**Science Processes**
a. Predicting
b. Observing
c. Comparing Data

IV. **Materials**
Shovel
Sheet metal
Black plastic sheet
Clear plastic sheet
Cloth
Can, cup or beaker
Measuring cup
Chart or graph paper

V. **Key Question**
Can the cooling of the air, which has been treated by the radiant heat of the sun, produce water?

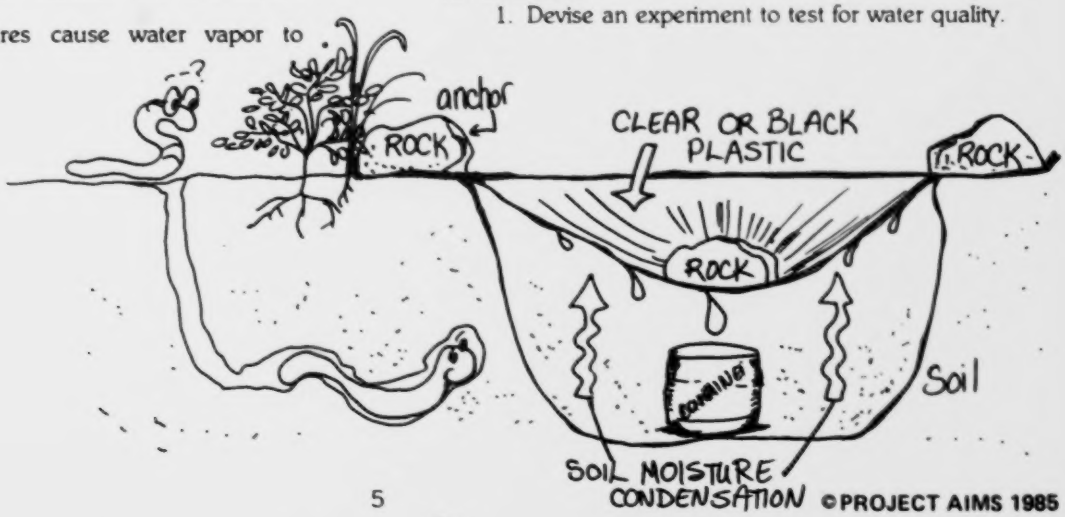
VI. **Background Information**
1. Most forms of energy on the earth can be traced directly or indirectly to the sun's radiant energy.
2. The processes of condensation and evaporation are the result of radiant heating and cooling.
3. Examples of various stages of evaporation and condensation are fog, mist, rain, snow and hail. Degrees of heating and cooling of the air creates the conditions for these conditions to occur.
4. The "water cycle" is the result of evaporation and condensation working in concert.
5. Warm temperatures increase the amount of evaporation.
6. Cooling temperatures cause water vapor to condense.

VIII. **Procedure**
1. Dig a hole in the soil, 1 meter in diameter, 50 cm deep.
2. Place container at center bottom of the hole.
3. Cover the hole with black plastic sheet. Do not stretch the plastic, rather, allow the plastic sheet to sag in the middle over the container, but not touching the container.
4. Place a stone or weight at the bottom center of the sag over the container.
5. Anchor the sheeting with rocks or soil around the top of the hole.
6. Wait several hours, lift the plastic sheet, measure the amount of condensed water collected and record findings.
7. Repeat the investigation several times using clear plastic or other materials and at day and night hours.

IX. **What the Students Will Do**
See above Procedure.

X. **Discussion**
1. Is there water vapor in the air?
2. Does warm air touching cool objects produce condensation?
3. Show that condensation increased during the night time investigation because the warm soil holds more water vapor. (Reverse process from day time investigation.)
4. Is water collected in container drinkable and can it help with survival, if necessary?
5. Did water appear? If so, how much?
6. Did more water appear during the day or at night?
7. Where did the water come from?
8. Why does the water condense? What factor increased condensation?
9. Do the results of the investigation relate to conditions resulting in fog, rain, clouds, etc?

XI. **Extension**
1. Devise an experiment to test for water quality.





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# On Living Pond

I. **Topic Area**

Plant, animal life, and environmental conditions of a pond.

II. **Introductory Statement**

Students will observe types of organisms that might be found in a freshwater pond.

III. **Math Skills**

a. Measurement
b. Graphing
c. Estimating
d. Finding Volume
e. Multiplying
f. Dividing

**Science Processes**

a. Classifying
b. Observing
c. Process Integration
d. Drawing Conclusions
e. Collecting & Organizing Data

IV. **Materials**

pH test paper
Notebooks, pencil, labsheets
Thermometers
Strainers
Rope
Baby food jars
Pie pans, dish pans (white)
Pond life guide books
50' — 100' measuring tape
Hand lenses

V. **Key Question**

What types of organisms might be found in a freshwater pond?

VI. **Background Information**

Pond studies will generate a great amount of spontaneous discovery. With that in mind, it is important to have materials available for the students to research their own discoveries and to stress that you may or may not find all types of plants or animals. As animals are collected the teacher should emphasize classification according to some logical grouping. Below are several general specie groupings which may be found in the pond habitat.

MICROSCOPIC ANIMALS - 1 celled
TYPICAL PLANTS - with roots; submerged or afloat
SPONGES - flattened green or yellowish masses (animals) on submerged sticks, stones or plants ½" long or less
HYDRAS - thread-like white/green animals hanging from sticks or stones in quiet water ¼ long
FLATWORMS (planaria) - soft grayish or black on underneath of stones; less than ¼" long
ROTIFERS - microscopic animals distinguished by rotating cilia or wheels at the front end of the body
THREAD/HAIR BRISTLEWORMS - transparent ½" long or less; red worms up to 1" or 2" long; hairlike 1 to 2 feet long
LEECHES - flattened worms with sucker on end clings to stones or sticks
CRUSTACEANS - many jointed animals range from microscopic to several inches
WATER MITES - brightly colored, red-orange, spider-like animals
WATER INSECTS - all have 6 legs on their thorax (body)
MOLLUSKS - snails, clams
FISH
SALAMANDERS/FROGS/TOADS
TURTLES/SNAKES

During the spring one of the most prominent insects will be the mosquito. Only the female of the specie actually bites and sucks blood. Males have plumose antennae. All mosquito larvae breathe air. Called wrigglers they travel up and down in the pond to alternately breathe and feed. Eggs are laid on the surface where, under normal conditions, they hatch within three days.

VII. **Management Suggestions**

Spring is usually the best time to visit and observe the pond. At least two hours should be allowed for the pond visit for the initial activity. Additional activities require more time.

VIII. **Procedure**

1. As you approach the pond, observe and discuss why a pond is located at that particular spot.
2. Divide students into small groups and assign them to different areas around the pond. Have them collect plants and animals — making sure to collect only one of each species and to note its location so that it may be returned to its natural habitat. Keep a tally of the total number of organisms found of each type for use in calculating percent later. Students return to a central location where the teacher has provided a classification guide and white dish pans labelled with general classifications. Students classify and record their findings and deposit the specimens in appropriate pans.


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3. Count all the organisms in each classification pan plus the tally kept by each group and record the number on the chart. Calculate the percent of each variety of organisms found by the total group.
4. Return organisms to their natural environment.
5. Using the pH test paper and a thermometer, record the data indicated on Student Worksheet 8. Remember to record predictions before any measurements are taken or recorded. Test may be taken at several locations and thermometers should be left in for at least two minutes.
6. Check the temperature of the pond at different depths. Use a weighted rope that is marked off in ½ foot sections with tape. Attach several thermometers at different locations on the rope and lower the rope to the bottom. After two minutes, raise the rope and read the thermometers. Record the results.
7. Measure the volume of the pond as described on Student Worksheet 9.

X. **Discussion**

1. Describe the water environment. Use all your senses.
2. What are some factors that affect the lives of animals in water?
3. Where would you expect to find animals in the water? (at what depths?) Why?
4. Regarding temperature readings, why might our predictions disagree with our actual readings?
5. Under what conditions might we expect to get different readings?
6. How many people do you think could be supported for one day from the water in this pond? (considering volume)
7. What might effect the amount of water in this pond?
8. How important is this pond to the environment?





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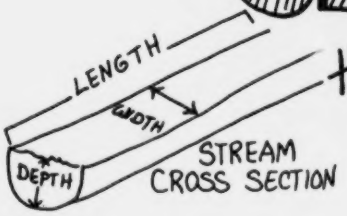
# Get with the FLOW




How much water is flowing past where we are standing?

I. **Topic Area**
Flow of stream water

II. **Introductory Statement**
Students will investigate and discover the Second Feet Flow of a stream at a given point.

III. **Math Skills**
a. Measuring
b. Estimating
c. Averaging
d. Graphing
e. Multiplying
f. Dividing

**Science Processes**
a. Observing
b. Measuring
c. Predicting
d. Recording Data
e. Making a Hypothesis
f. Interpreting Data

IV. **Materials**
50' to 100' measuring tape
Meter sticks
3 tennis balls or corks
3 stopwatches
String or cord
Record book or paper
Graph paper
Pencils

V. **Key Question**
1. How much water is flowing past where we are standing?
2. Can we estimate the amount of water passing us?
3. How do we measure stream flow?

VI. **Background Information**
A. Definition of terms:
1. STREAM FLOW - Stream flow is measured in second feet or cubic feet per second.
2. CUBIC FOOT - 1 cubic foot per second is commonly know as one second foot flow.
3. SECOND FEET FLOW - Second Feet Flow formula:

Second Feet

or

$$\text{Cubic Feet per sec.} = \frac{\text{Volume (W) X (D) X (L)}}{\text{Time (sec)}}$$

Second—Feet Flow — Quantity of water flowing past a given point on a stream or river in a given time.

4. VOLUME - $\text{Velocity} = \frac{\text{Number of feet}}{\text{1 second}} = \text{feet per sec.}$

B. Importance of Second Feet Flow Data - Practical Applications:
1. FLOOD CONTROL - During storms, stream flow observation is necessary in predicting flood conditions.
2. IRRIGATION - Irrigation Districts buy and sell water based on measured stored water supplies. Supplies of water are determined by stream flow calculations.
3. RESERVOIR REGULATION FOR RECREATION - Recreation water is stored irrigation water in the valley foothills.
4. RIVER REGULATION FOR WHITE WATER RAFTING AND OTHER WATER SPORTS - Adequate stream flow is maintained for recreation on dam controlled rivers and streams.

VII. **Management Suggestions**
1. Selection of test-site-safe banks, wide area where flow is not too fast.
2. Appoint students to:
   a. Measure Width
   b. Measure Depth
   c. Set 100 Ft. Distances
   d. Timers
   e. Tennis Ball Starters & Retrievers
   f. Recorders
3. Plan to spend at least one hour for investigations, Extension activity may take longer.
4. It is best to pre-evaluate site for investigation.
5. Extension Activities may include:
   1. Field trip to dam site
   2. Seasonal data collection of stream flow
   3. Classroom speakers to relate importance of stream flow, water collection, etc.



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VIII. **What the Students Will Do**

1. Mark off 100 ft. (50 ft. if only that distance is available)
2. Stretch string across stream at beginning and ending points of that portion of the stream where investigation will take place.
3. Students predict the time it will take a tennis ball to travel a distance. Try other floating objects and record.
4. Measure the time it takes the tennis balls to cover the 100 foot distance.

$$\text{Velocity} = \frac{\text{Feet traveled}}{\text{Time (sec)}} = \text{Feet per second}$$

5. Repeat several times to determine the average time.
6. Record each time to determine consistency of stream flow.
7. Measure the volume of water in the 100 ft. length.
8. Measure width (w) at several points. Find the average.
9. Measure depth (d) + several points. Find the average.
10. Multiply average width (w), X average depth (d), X length (l) to determine volume.

$$\text{Volume} = (W) \times (D) \times (L)$$

11. Estimate and calculate Second Feet Flow (cubic feet per second) by the formula:

$$\text{Second Feet Flow} = \frac{\text{Volume (W) X (D) X (L)}}{\text{Time (sec)}}$$

EXAMPLE: 18' wide X 3' deep = 54 sq. feet (Area)

$$54 \text{ sq. ft. X } 100' = \frac{5400 \text{ ft}^3}{108 \text{ sec.}} = 50 \text{ cu. ft. per sec. OR}$$

Second Feet Flow = 50 cubic feet per second

12. Make several calculations at different spots on stream and graph.

IX. **Discussion**

1. What was the area of the measured section?
2. What was the velocity of the stream?
3. How much water is passing through the measured section?
4. Does water flow faster in a wide/shallow stream or in a narrow/deep stream? Why?

X. **Extension**

1. Taking the information (data), students may calculate the number of acre feet of water the stream will produce in a 24 hour period.

1 cu. ft. per sec. flow X 24 hrs. = 1 acre 2 ft. deep
OR 2 acre ft.

Does the velocity of the stream vary at different depths?


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# TRANSPIRATION — Why Are Plants So Thirsty?

I. **Topic Area**

Plant ecology

II. **Introductory Statement**

Plants have a cooling effect on our environment due to the "air conditioning" created by the evaporation of water through the surfaces of plants. This process is called transpiration. Students will understand why plants require so much water to survive and why they die so quickly when water is not present.

III **Math Skills**

a. Metric Measurement
b. Graphing
c. Computing Rate & Volume

**Science Processes**

a. Predicting
b. Estimating
c. Controlling Variables
d. Interpreting Data
e. Applying & Generalizing

IV **Materials**

Two hole stopper (to fit flask)
Glass tubing, bent to a right angle
Large bowl
Leafy shoot (1 per group — leafy chrysanthemum with white bloom)
Solid glass rod
Knife
Rubber tubing, about 20 cm long
Erlenmeyer flask, 500 ml
Oil based clay
Pipette (1/10 ml calibration)
Cork
Water at room temperature
Burette clamp
Ring stand
Clock
Graph paper, one sheet per student
Pencils, 3 colors
Plastic bags and ties
Small fan
Food coloring

Alternate equipment list:

1. Syringes calibrated to tenths of cc (1 cc = 1 ml) can be substituted for pipettes. They can be obtained at a veterinary supply house.
2. Any jar which can be stoppered by a rubber stopper or clay ball can be substituted.
3. A clay ball (oil based clay) can be substituted for the stopper.
4. The glass tubing could be eliminated if the clay stopper were used. The hose could be introduced into the bottle directly through the clay.
5. A stack of books and a clothespin can be substituted for the ring stand.

V **Key Question**

Why do plants require so much water?

VI. **Background Information**

All plants lose water through evaporation. A mature apple tree, for example, will lose up to 15 litres of water an hour. A single corn plant can lose 200 kg. of water during a growing season. A majority of this evaporation takes place through the surfaces of the leaves, but water is lost through all of the surfaces of a plant.

The state of evaporation will depend on several variables. Transpiration increases in dry air and decreases in moist air. Factors that affect air moisture levels also affect transpiration rates. Consequently, plants lose more water on hot, dry days than on cool, moist nights. Windy conditions also increase transpiration rates because the evaporated moisture around a plant is more quickly carried away to be replaced by drier air.

Plant wilting is related to transpiration. The plant's stiffness depends on the pressure of protoplasm against the plant cell walls. Protoplasm consists mostly of water. When the loss of water through transpiration is greater than the ability of the plant to replace the water, wilting occurs because the protoplasm no longer exerts the same pressure on the cell walls. When the pressure of the protoplasm decreases, the cell walls lose some of their rigidity, and the plant wilts.

VII. **Management Suggestions**

If equipment shortage is a problem the procedure can be done as a center activity. Later, the whole group can meet together to pool results and discuss findings. Plants vary in their transpiration rates. Generally, plants with non-waxy leaves have higher rates of water loss. Carnations use a lot of water and are good to use with the dye. If the plant takes water too slowly to produce a visible change in readings extend the experiment over a longer period. See the Alternative Equipment List and the alternate diagram if obtaining any of the equipment items is a problem.

The three sets of readings can be taken on successive days. Prior to each test refill the pipette or syringe. Conducted in this manner the experiment will take at least four 1 hour periods.

VIII. **Procedure**

1. Place the pipette in the cork.
2. Place the bent glass tube into the two hole stopper.
3. Place one end of the rubber hose onto the glass tube.
4. Seal around the glass tube with clay.
5. Place the Burette clamp onto the ring stand.
6. Teacher should also set up the control experiment using the solid glass tube instead of the leafy shoot.



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IX. **What the Students Will Do**

1. Place the leafy shoot under water and cut off about 2 cm of the stem.
2. Keep the cut end of the stem underwater as you place the stem into the empty hole of the stopper. The stem should fit snugly into the hole.
3. Fill the flask and rubber tube with water and add food coloring to the water. Hold tube pinched so water does not drain out.
4. Quickly place the stopper into the filled flask so that water runs up into the glass tube. Some water will overflow. Keep rubber tube pinched to keep it filled with water.
5. Seal the stem into the stopper with clay.
6. Fill the pipette with water and place it into the open end of the rubber tubing. Note — Keep the beaker top elevated above the water level in the pipette to avoid a syphoning effect.
7. Fill the pipette with water and place it into the open end of the rubber tubing.
8. Clamp the pipette onto the stand.
9. Record the level of water in the pipette and time the reading was taken.
10. Take readings every 5 minutes until 8 readings are recorded.
11. After the eighth reading begin fanning the leaves. Keep up a constant fanning while readings are taken every 5 minutes until 8 more readings have been taken. (Use the fan here if desired.)
12. After the sixteenth reading loosely cover the leafy shoot with a plastic bag. Tie the gathered bag around the stem at the bottom. Take readings every 5 minutes until another 8 readings have been taken.
13. Graph your results using a line graph. Use colored lines to represent each phase of the experiment.
14. Leave the experiment for a day and then observe the results.

X. **Discussion**

1. What happened to the flower and why?
2. How much water was lost between the first and eighth reading of your experiment? Where did the water go?
3. How does this water loss compare with the results of the control experiment?
4. How can you explain the difference:
5. How did fanning the leaves affect the water loss?
6. Can you explain this difference in readings?
7. How did the bag covering the leaves affect the water loss?
8. Can you explain the difference in the readings?
9. Why did we seal the connections of the experiment?
10. Why did we have the control experiment? How was the control experiment set up differently?
11. How much water would your shoot have lost in an hour if it had been left in the bottle?
12. How much water would your shoot have lost in an hour if left in a constant breeze?
13. How much water would have been lost if the bag had been left on for an hour?
14. How much water would a plant with 50 times the number of leaves as your shoot lose in an hour if not covered or in a breeze?
15. How much would the plant in problem 13 lose if left in a breeze like the one created by your fanning?
16. What happens to a plant when it is taken out of the ground?
17. Why does this happen?
18. Gardeners have to frequently take plants out of soil to transplant them. What weather conditions do you think would be best for the survival of plants if they are to be transplanted? Why?
19. What happens to plants in the hot sun when they are not watered?
20. Why does this happen?
21. How could a plant out of ground be preserved until it is replanted?

XI. **Extension**

1. Experiment to compare transpiration rates in the sun vs. the shade.
2. Compare leaf types based on transpiration rates.



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# THIRSTY GREENS

I. **Topic Area**
Transpiration

II. **Introductory Statement**
Students will learn that plants release moisture into the air through the leaves.

III. **Math Skills**
a. Measuring
b. Estimating
c. Graphing

**Science Processes**
a. Observing
b. Predicting & Estimating
c. Recording Data

IV. **Materials**
Graduated cylinders
Plastic bags
Pebbles
Rubber bands
Centimeter grid paper
Pencil/paper

V. **Key Question**
How much water is given off by trees and plants?

VI. **Background**
Plants lose water through their leaves through a process called tanspiration. Large quantities of water are released into the atmosphere through this process. A mature maple tree, for example, may give off as much as 15 liters of water in a single hour.

VII. **Management Suggestions**
The amount of water you collect will depend on weather conditions. If dramatic results are obtained, observations and measurements may be taken several times a day. If the amount of water is too small to measure, the experiment may be continued over several days.

VIII. **What the Student Will Do**
1. Within a heavily foliaged area, select different plants with different size leaves.
2. Select a small branch with several leaves and cover them with the plastic bag. Record the time at which the leaves were covered.
3. Place a pebble in the bag to force the bag to droop so moisture can be collected in the low area reservoir.
4. Secure with a rubber band.
5. When results are visible, record time, uncover and measure the amount of water in a graduated cylinder.
6. Record results and compare the amount of water obtained from the different experimental plants.

X. **Discussion**
1. Does the leaf size seem to have an effect on the amount of water given off by a plant?
2. Does the size of the plant contribute to the amount of water given off through the leaves?
3. Where does the water come from?

XI. **Extension**
1. Count the number of leaves on a single branch. Multiply by the number of branches on the plant and estimate the approximate amount of water released by that plant during a single day.


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# DISAPPEARING DRIPS

I. **Topic Area**

Moisture holding capacity of different soil types

II. **Introductory Statement**

Students will learn that different soil types from different habitats retain varying amounts of moisture.

III. **Math Skills**

a. Graphing
b. Subtracting
c. Measuring
d. Percent

**Science Processes**

a. Predicting & Estimating
b. Recording Data
c. Measuring
d. Controlling Variables
e. Observing
f. Applying & Generalizing

IV. **Materials**

Balance and metric masses
Pencil/paper
Water
Graduated 500 ml containers
Graduated cylinders
Perforated coffee cans
Quart jars
Masking tape
Digging instrument
3 or more soil samples
"Mr. Coffee" coffee filters

V. **Key Question**

How much water can these soil samples retain before they become saturated?

VI. **Background Information**

A soil's ability to absorb and retain water are key factors in its ability to halt erosion and support plant life. Soil is made up of very small particles of rock, plant, and animal materials that were once part of larger pieces. The size of the particles can be classified into sand, silt, or clay. This varying make-up of the soil composition is the key factor in the retention of moisture. Soil should be dry prior to the activity. If weather conditions prevent soil from drying outside, drying may be done on low heat in the oven.

VIII. **Procedure**

1. Weigh the soil sample with the coffee filter on a balance and record.
2. Remove filter and sample and place them into a coffee can that has a perforated bottom.
3. Set the can on top of the quart jar and carefully pour 500 ml of water into the can.
4. Let the water settle in the can. Remove the can and remeasure the water in the jar by pouring it back into the graduated ml container. Record the difference and calculate the percent of water that has been retained by the sample.

   Example: 500 ml poured in
   300 ml remeasured amount of water

   $$500 \overline{)\ 300}^{\ 60\%}$$

   therefore, 40% of the water was retained by the soil
5. Remove the filter with the sample and reweigh to calculate the weight of the water retained. Percent can be determined from this measurement also.
6. Repeat experiment with the other soil samples. Use exactly the same weight and the same amount of water for each sample.

X. **Discussion**

1. What samples held the most water?
2. Did all samples that weighed the same have the same amount (volume) of soil?
3. What might contribute to good soil?
4. How might a soil's ability to hold water relate to erosion?

XI. **Extension**

1. Students can see if the soil in a given area is saturated by repeating the experiment above but using non-dried soil samples. Using various habitats — ie. stream, pond, hillside or meadow, students should be able to determine where the largest amount of water collects.
2. Students can determine the percentage of sand, silt, or clay composition of a soil sample. Again, selecting different soil samples from various habitats (need not be dried), place the samples into the graduated cylinder. Note and record the amount of soil. Fill with water, then shake.

   As the sample settles out, record the time. Sand will settle out in 1 minute, silt in less than 10 minutes and any suspended particles after 10 minutes may be classified as clay.
   Check the amount settled out after one minute, record and divide for percntage. Repeat the process after 10 minutes.
   Example: After 1 minute, 30 ml was measured

   $$40 \overline{)\ 30.00}^{\ .75}$$

   = 75% of the sample is considered sand
   After 10 minutes, almost all was settled, but the water was somewhat cloudy.

   $$40 \overline{)\ 39} = 97\%$$

   ∴ 75% sand 22% silt 3% clay


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# Discovering Dirt

I. **Topic Area**
Soil analysis

II. **Introductory Statement**
Soils are not all alike. Each type of soil has its own characteristics. In this experiment students will learn how to classify soils and how to make predictions about soil characteristics.

III. **Math Skills**
a. Fractions
b. Decimals
c. Percents
d. Charting

**Science Processes**
a. Observing
b. Classifying
c. Measuring
d. Interpreting Data

IV. **Materials**
Straight sided jars and lids
Metric rulers
Soil samples (3)
Tagboard

V. **Key Question**
What are the sample soil types and what characteristics will they have?

VI. **Background Information**
Soils are a combination of various sized particles. There are three basic categories of particles that exist in soils. The smallest particles are called clay. Clay particles are less than 1/12,500 of an inch in size. Silt particles are those larger than 1/12,500 of an inch but smaller than 1/500 of an inch in size. The largest particles are called sand. Sand particles can range from 1/500 of an inch up to 1/12 of an inch in size. Soils are distinguished by observing the percentage of each of the three types of particles contained in the soil. (See soil chart)

Soils vary in their ability to be cultivated. The combination of particle types dictates how the soil will handle, drain, and hold water. Soils that contain a large percentage of clay hold water tightly but they drain poorly. Clayish soils are sticky and difficult to work. Plants growing in clay suffer from a lack of air around the roots because the tiny clay particles pack together so tightly that there are few air spaces in the soil. The tightness of soil packing explains why clayish soils drain so poorly. The clay particles hold the water tightly preventing it from being used by plants or draining away.

Sandy soils on the other hand are very easy to work. They also provide an ample air supply to roots because the large particles do not pack tightly together. Sand, however, does not hold water well. Water drains quickly through the loosely packed sand and thus is not available to the plant. Plants in sandy soils need very frequent waterings.

The best growing soils combine the airiness and drainage of sand with the water holding capacity of clay. Loam soils that contain approximately 40% sand, 40% silt and 20% clay are considered the best cultivating soils. Nursery growing mixes are usually artificial loam soils.

VII. **Management Suggestions**
1. Groups of 3 work well, each member of group testing a different soil sample.
2. Before doing experiment discuss the 3 basic soil components and the qualities that each add to the soil.
3. Experiment takes 2 one-hour periods. One is used to discuss soils and set up jars. After a settling period of 24 hours, jars are examined and classified.
4. If soil layers are difficult to distinguish, consider the layer formed during the first minute as sand, the layer formed between one minute and 15 minutes as silt, and everything else as clay.

VIII. **Procedure**
Prepare or find 3 distinctly different soil samples.

IX. **What the Students Will Do**
1. Fill jars 2/3 full of water.
2. Pour soil into jar until water is nearly to top.
3. Place lid on jar tightly and shake vigorously until all soil is suspended.
4. Set the jars in a place where soil will not be disturbed for 24 hours. Wait 24 hours.
5. Observe the layers of sediment. Measure the total depth of sediment and the width of each layer. Record these figures on the chart.
6. Use the tagboard to make a soil chart representing the width of each sediment layer.
7. Compute the percentage of sand, silt and clay found in the sample.

   Example: $\frac{\text{\# of mm sand}}{\text{\# of mm sample}}$ = decimal fraction of sand

   Convert decimal to percentage.
8. Classify the soil sample by comparing its chart and percentages to the master chart.
9. Describe the qualities of the soil sample as they would compare to the qualities of loam. That is; Does your soil have better, worse or the same drainage, water capacity, airiness and ease of handling as loam? State reasons for your statements.

X. **Discussion**
1. Discuss the 3 types of soils and the qualities of each.
2. How could the soils be improved for cultivation purposes? (Sand, humus, or clay added perhaps.)

XI. **Extension**
1. Take soil samples from various environments and compare. Also compare plant growth in each soil.
2. Test water holding capabilities of samples. (How much of a pint of water will a prescribed volume of soil hold?)
3. Test drainage capabilities of soils. (How fast does a saturated soil sample drain off a pint of water?)


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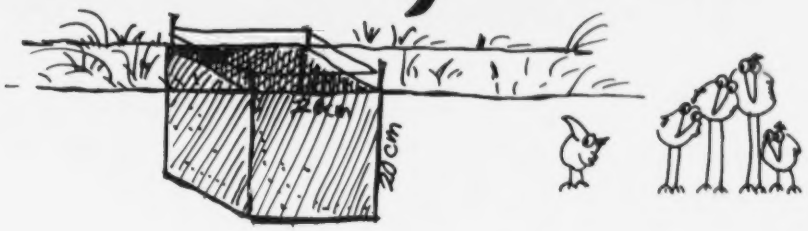
# Habitat Comparisons




I. **Topic Area**
Environmental study

II. **Introductory Statement**
Students will gain an appreciation for the difference between habitats and the types of organisms that can be supported.

III. **Math Skills**
a. Measuring
b. Counting
c. Subtracting
d. Graphing

**Science Processes**
a. Observing
b. Classifying
c. Recording Data
d. Hypothesizing

IV. **Materials**
Thermometers
Metric rulers
Dull kitchen knife/spoon
String
Popsicle sticks or tongue depressors
Graph paper
Pie tins
pH paper or soil test kit
Area that includes two or more varying habitats

V. **Key Question**
What are some measurable differences between a forest and a meadow habitat?

VI. **Background Information**
This is an investigation which will make students aware of the physical differences between habitats. In the forest, for example, the temperatures will be lower, the pH (acidity/alkalinity) of surface soil will vary, and the amount of organic debris will differ from that of an open meadow.

VII. **Management Suggestions**
This activity will require approximately 1½ hours. Two 45 minute class periods may be used if you can save your samples.

VIII. **Procedure**
1. Have students observe the habitat and discuss their observations. Look for evidence of logging, small tree encroachment, too much water, lowland swamp, shallow soil, rock outcroppings, etc. Record observations.
2. Divide students into groups and assign them to different areas following the directions on the student worksheet 18.

X. **Discussion**
1. Why do you think animals burrow underground to live?
2. Why do you think that there is a temperature difference among habitats?
3. What type of soil supports a greater variety of plant life?
4. What might be a reason for this difference?
5. Does the amount of organic material seem to effect the pH readings of the soil?
6. What might happen to the deer population if a fire destroyed areas of the meadow?

XI. **Extension**
1. Compare habitats. Include areas that have water.
2. Students can calculate how many deer could be supported in certain habitats. Necessary information includes:
   — 1 chain is equal to 66 feet
   — 10 square chains equal one acre
   — 1 acre of chaparral can produce 300 lbs. of forage per year
   — 1 acre of meadow can produce 500 lbs. of forage per year
   — 1 acre of forest can produce 100 lbs. of forage per year
   — 1 adult deer requires 3,650 lbs. of forage per year

   Measure out an acre from a meadow habitat. Then roughly step off the amount of meadow land needed to support one adult deer for one year.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# TREE COOKIES

I. **Topic Area**
Growth rings of trees

II. **Introductory Statement**
Students will gain a knowledge of the factors that affect tree growth.

III. **Math Skills**
a. Multiplying
b. Dividing
c. Finding Circumference
d. Finding Diameter
e. Finding Radius
f. Using Ratios
g. Graphing

**Science Processes**
a. Observing
b. Measuring
c. Collecting Data
d. Predicting
e. Making & Testing Hypothesis
f. Making Inferences & Generalizations

IV. **Materials**
Tree cookie: cross section of a tree trunk may be obtained from the Forest Service or a local tree trimming company.
Metric tapes
Slate or chalk boards (optional)
Graph paper
Rulers/pencils
Increment bore (optional)

V. **Key Question**
What information can be determined about tree growth from analyzing a cross-section of the tree's trunk?

VI. **Background Information**
Tree growth depends on environmental factors including location, surrounding foliage, water and temperature. The yearly variance of these factors may be reflected in a tree's annual growth rings. Counting these growth rings gives a fairly accurate account of a tree's age. The wider the rings, the more growth. The narrow rings will indicate less growth due to drought or cold cycles. Growth occurs only in one small microscopic layer of the tree called the cambium. The cambium layer lies next to the sapwood. As it produces cells, the tree grows. The other parts of the tree trunk are basically dead. The pith is the center of the rings. Its position, whether in the exact center of the round or offset to one side, can indicate growth factors like the amount of shade from surrounding foliage. The heartwood is the darker area surrounding the pith that consists of closed capillary passages. This former sapwood now functions as the fortification part of the tree. The sapwood is the next layered section. It is lighter in color than the heartwood (if the round is a fairly fresh cut). The sapwood functions as a transportation system for the fluids and nutrients to pass up the tree to the outer branches and leaves. The inner cells become sapwood while the outer cells become the inner bark. This moist layer will eventually dry and help to replace the rough exterior, or outer bark. The inner bark helps transport fluids down the tree from the leaves to the roots.

VIII. **Procedure**
1. Distribute tree cookies or rounds to groups with measuring tapes. Identify various parts of the tree trunk.
2. Measure the diameter. Multiply by (3.14) to find the circumference. (C = X d) Measure the circumference to check accuracy.
3. Check the location of the pith. Is it in the center.
4. Count the rings marking off each decade. Figure the percent of growth for each ten year period. Do this by dividing the measured section by the total radius.

Example: total radius = 40 cm
1st decade = 15 cm

$$40 \overline{)15.00} = .375 = 38\%$$

In the first ten year period the tree received 38% of its growth.

5. Count the number of limb whorls as produced by lateral buds. For some species, this is also a fairly accurate way of determining the age of a tree.

X. **Discussion**
1. How can we identify the heartwood from the sapwood? The inner bark from the outer bark?
2. What is the constant when you divide the circumference by the diameter? What is the relationship between the diameter and the radius?
3. What factors do you think might affect the position of the pith?
4. When does a tree have its greatest percent of growth?
5. Are the rings of the tree all the same size? What might account for the different widths in the rings?
6. Is there a relationship between trees within a certain area?
7. Can we determine what year a tree germinated?
8. Are trees with the same diameter the same age? Why?

XI. **Extension**
1. Measure the circumference of several surrounding trees. Calculate the diameter. Using an increment bore, sample various trees and compare the number of rings with the diameter. Groups may sample trees of the same variety or trees of different kinds. Circumference should be measured at a height $4\frac{1}{2}$ feet from the ground, called chest height.


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# TREES as a CROP

I. **Topic Area**

Forestry and tree harvesting

II. **Introductory Statement**

Students will learn how foresters manage and maintain the forest as a continually producing crop. They will also be introduced to concepts behind the measurement of trees and their productivity.

III. **Math Skills**

a. Measuring
b. Addition
c. Subtraction
d. Multiplication
e. Circle/Diameter Concepts

**Science Processes**

a. Measuring
b. Estimating & Predicting
c. Recording Data
d. Interpreting Data

IV. **Materials**

Biltmore stick
Chain — 66 ft. length
Board feet chart
Pencil/paper
Measuring tape
Clinometer (included in worksheet p. 36)
String
Clinometer conversion chart

V. **Key Question**

How many houses could we build from a single tree?

VI. **Background Information**

About 100 years ago, the forest was exploited as an inexhaustible resource. Today the forest industry plans for the future. Modern forest planning includes extensive reforestation projects, continuing research on tree disease, and creative land use protection.

In order to insure a continuing crop of trees for future generations, new logging practices have been enacted. In some areas, selective cutting is used while in other areas clear cutting is practiced in order to reduce the competition between young replantings and more mature trees.

It is also important to determine the expected yield of a stand of trees. To do this, forest professionals called timber cruisers are employed to survey, mark, and calculate the number of board feet in a given location or in a specific tree. This project is one way timber cruisers determine the board feet in a tree.

**The Biltmore Stick**

The Biltmore stick is used together with the conversion chart to determine approximate board feet in a log. The Biltmore stick is premarked to give the number of 16' logs in a tree (height) standing at a distance of 1 chain (66 feet) or 1½ chains (99 feet) away from the tree. At that distance, the stick is held at shoulder height, arm extended. The forester then sights the top of the tree and notes the measurement that coincides with the sighting.

After the number of 16' logs has been determined the diameter of the tree is needed. This may be obtained by measuring the circumference and solving for diameter.

Example: C = 141 inch  D = C ÷ π  π = 3.14

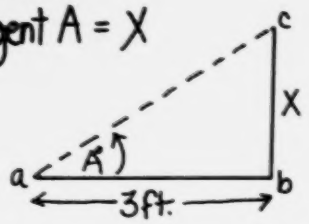
141 ÷ 3.14 = 44.9 or 45 inches

Another way is to use the Biltmore stick sideways and holding it at arm's length, site the approximate diameter. Note: All diameter measurements should be taken at a height of 4½' from the ground called breast height. Using the height and diameter measurements use the board feet conversion chart to determine the approximate number of board feet in the measured tree.

The Biltmore stick is based upon simple trigonometric functions. This principle is also used when we measure heights using a clinometer or the old Indian method.. Briefly explained, if you know the distance ab and A you can determine the height of bc or X.

★ Tangent is determined from a tangent chart. (Included with the worksheets)

FORMULA: ab x Tangent A = X




Example: If ab = 36'

A = 35°  ∴Tangent A = .7002

36 X .7002 = X

25.2072 = X  ∴the height is approximately 25'

While this may be too complicated for many students the concept may be introduced to those that find the use of the clinometer conversion sheet too easy.



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VIII. **Procedure**

1. After a brief background introduction, divide the students into groups of five and designate a tree for them to measure. Preselected trees will insure that the data will fall within the given chart.
2. Pass out the appropriate equipment for each group.
3. Students measure the diameter of the tree.
4. Using your chain, mark the distance of 1 chain (66 feet).
5. Hold the Biltmore stick vertically at arms length and at shoulder height.
6. Sight the top of the tree along the stick. Where your eye sight passes through the stick note the measurement and record.
7. Using the diameter and the Biltmore height, calculate the number of board feet in the tree.

X. **Discussion**

1. What are some factors foresters may have to consider before they mark a tree to be harvested?
2. Were there any signs of disease or deformities in the tree you worked with?
3. If those trees were harvested, what could be done to prevent erosion before young trees and shrubs established themselves?
4. What might be some factors that would account for variations in our measurements?

XI. **Extension**

1. Once the amount of board feet is calculated, students may wish to extrapolate this information into how many houses could be built out of one tree or how many trees it would take to build a house. Note: a 2000 square foot home framed would contain approximately 4000 board feet of lumber, and approximately 7000 board feet when completed, including kitchen cabinets.

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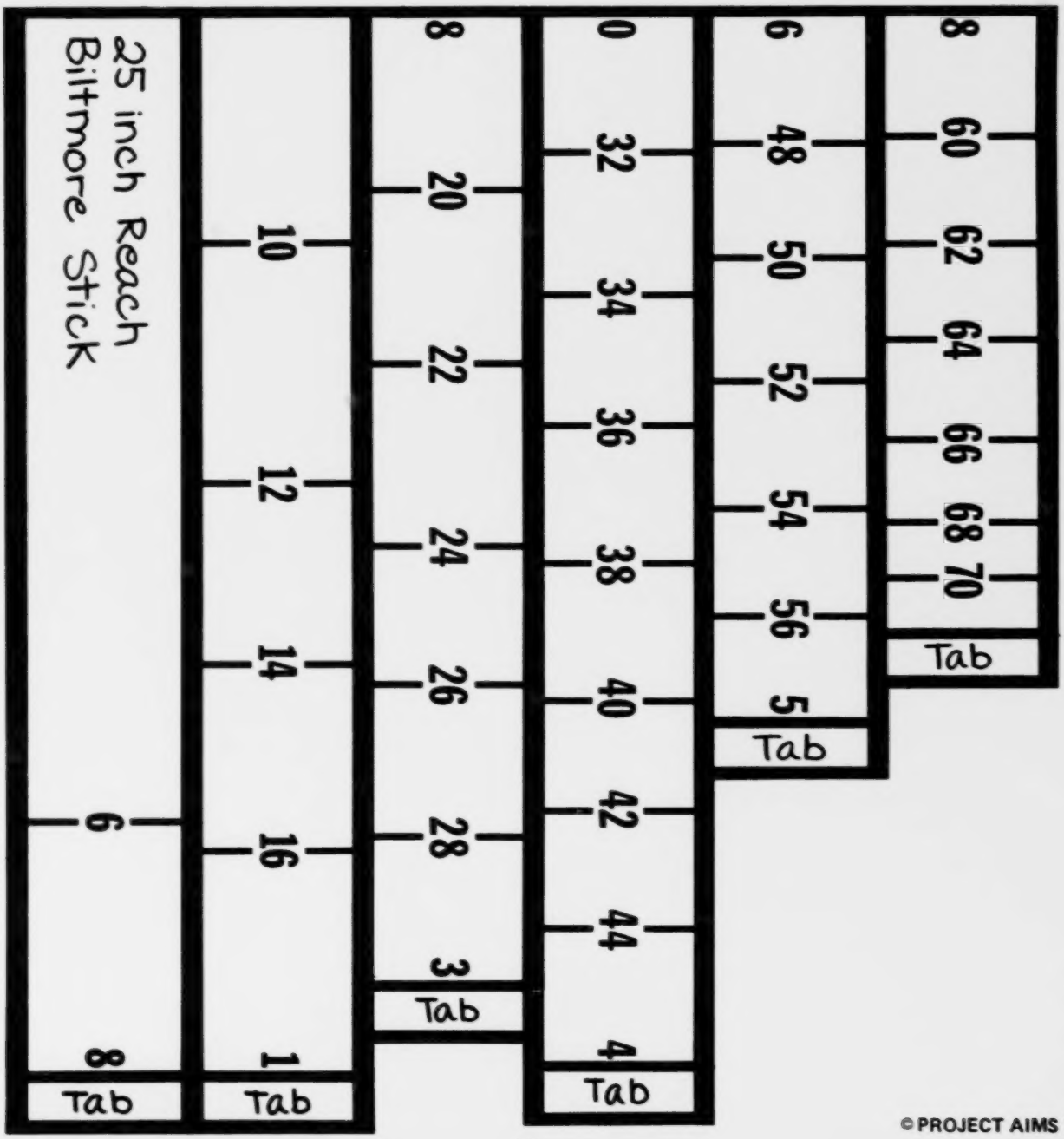
NAME

# TREES as a CROP

Side 1 of Biltmore Stick

- Cut on heavy black lines
- Join each section at tabs
- Join side 1 to side 2 - back to back

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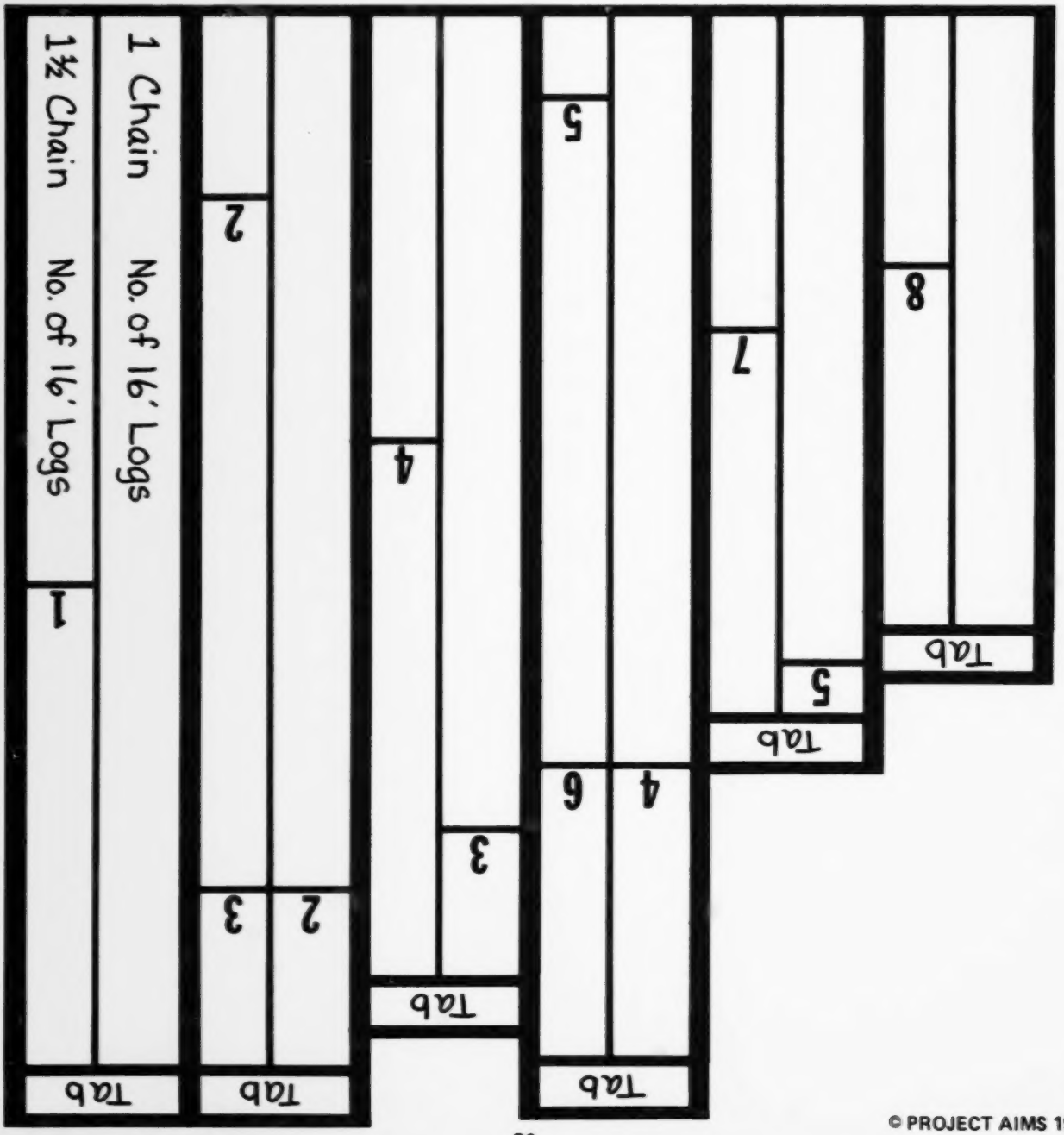
NAME _____

# TREES as a CROP

Side 2 of Biltmore Stick

- Cut on heavy black lines
- Join each section at tabs
- Join side 1 to side 2 - back to back

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# NATURE'S FOOD FACTORIES

I. **Topic Area**
Classification of leaves

II. **Introductory Statement**
Children will observe many different leaves while on the trail providing opportunities for them to categorize and determine likenesses and differences of leaves.

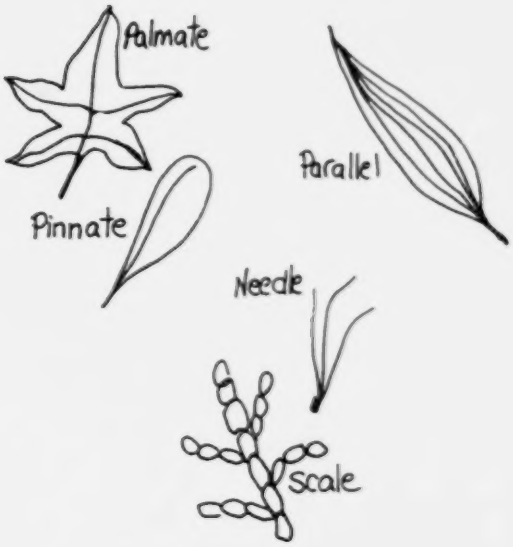
III. **Math Skills**
a. Measuring
b. Addition
c. Multiplication
d. Charting
e. Graphing
f. Averaging
g. Percent

**Science Processes**
a. Observing
b. Collecting Data
c. Classifying
d. Measuring
e. Organizing Data

IV. **Materials**
Measuring stick — meter stick or tape
Variety of trees and shrubs in natural or school ground setting
Graph paper
Pencils
Paper or plastic bags for collecting leaves

V. **Key Question**
How many different ways can we identify and group the many different kinds of leaves we have found?

VI. **Background Information**
1. Different leaf producing trees or shrubs grow in different ecological niches. Children, by observing, will begin to notice these differences. Trees grow in communities. Similar trees will grow in similar areas.
2. Leaves are the food factory for the trees. Leaves manufacture food for the tree through the process of photosynthesis.
3. Leaves need sunlight for photosynthesis to take place.
4. Normally, large leaves exist in darker, cool areas. Small leaves exist in bright, hot areas because the amount of light required for food manufacturing is directly proportional to the size of the leaves.
5. Some trees are evergreen and maintain their leaves year round. Others are deciduous and lose their leaves annually.
6. Pine needles are the leaves of the pine or coniferous trees. These leaves are found in bundles.
7. Leaf margins or edges are either serrated or smooth.
8. Leaves may be classified by their primary vein structure.




VIII. **Procedure**
1. During a trail walk, collect leaves from different communities (niches).
2. After returning from the trail, have students examine leaves and categorize the leaves by any characteristics of the leaves that the student may discover.
3. Have students record the various characteristics of the leaves.



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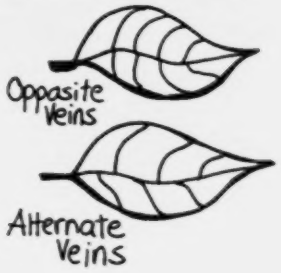
4. Ask students to group leaves by the characteristics below. Each category may be investigated as a separate exercise. Combining categories will be productive for more in-depth classification skill building.
   a. size of leaves
   b. length of leaves
   c. color of leaves
   d. pointed or smooth
   e. shiny or dull
   f. shape of leaves (heart-shaped, oval, round, diamond, feather)
   g. number of points or lobes
   h. width of leaves
   i. broadleaf or needle
   j. hard or soft
   k. opposite or alternate veins
   l. area where leaf was collected




5. After the students have recorded their findings, determine the percent of the whole collection that each category represents. Results may be used to produce charts or graphs.
   x. Number of leaves in grouping
   y. All leaves in sample
   z. % of total
   Formula y/x = z (percentage)
6. Determine the average width and length of identified leaves and record.

IX. **Discussion**

1. Discuss the various like characteristics of the leaves.
2. Discuss the various unlike characteristics of the leaves.
3. How many groups of leaves did you discover?
4. What is the average size and length of the different leaves from each niche?
5. What did you notice about the structure of various leaves (needles, veins, etc.)?
6. What were the common characteristics of most of the leaves that we found? Does the information give us a clue about the predominant ecological niche in the area? Why?

X. **Extension**

Mathematics - String Graph: Have students lay string around the exact perimeter of a leaf, cut string to length, measure, glue string to construction paper according to lengths.

Art — Trace leaf on paper.
Art — Place leaves on paper and spray paint.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# FLY BY HEAT

I. **Topic Area**
Insect response to temperature change

II. **Introductory Statement**
Students will gain a knowledge of the temperature factors that affect insect movement.

III. **Math Skills**
a. Addition
b. Measurement of Temperatures

**Science Processes**
a. Observation
b. Recording Data
c. Interpreting Data

IV. **Materials**
Several bees and flies
Two 1-quart jars with lids
Stopwatch
Two thermometers
Heat source — heat lamp

V. **Key Question**
Why are flies easier to catch in the morning? When do bees work harder — when it's cold or warm?

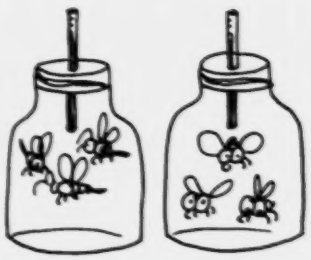
VI. **Background Information**
Insects are very susceptible to temperature changes, especially cold. This project is designed to demonstrate the temperature at which bees will work most productively. This is very important to farmers who depend on bees for pollination. Flies also react to temperature variations.

VII. **Management Suggestions**
1. Before catching any bees, be sure to check for students who may have allergic reactions to bee stings.
2. If you expose the insects to temperatures beyond those indicated on the student worksheet, death of the insects may occur.
3. This activity takes approximately one hour.

VIII. **Procedure**
1. Poke a hole in the lids of two 1-quart jars and insert a thermometer in each jar.
2. Put several bees in one jar and several flies in the other jar.
3. Insert both jars in a refrigerator until insects have ceased all movement.
4. Remove jars and record the temperatures. Focus heat on the jars and continue to monitor temperatures while observing movements of the insects (twitching, walking, or flying).
5. Record temperatures, time, and descriptions of movement on the student worksheets.

X. **Discussion**
1. How might this information help farmers?
2. Do all insects react to temperature changes in the same way?

XI. **Extension**
Students may also want to test temperatures where pollen is located in flowers, the work site of the bees.



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# NOW YOU SEE IT, NOW YOU DON'T

I. **Topic Area**

Natural selection and camouflage.

II. **Introductory Statement**

Students will investigate how some animals may have greater protection from their enemies (natural selection) because of their ability to blend into their surroundings.

III. **Math Skills**

a. Whole Number Operations
b. Percent

**Science Processes**

a. Observing
b. Collecting Data
c. Analyzing Data

IV. **Materials**

1 sheet 22" X 28" railroad or poster board in each of these four colors: black, yellow, green, or pink (or your favorite choice)
Paper cutter or sharp scissors
Standard hole punch
Strong bench, table, or step ladder

V. **Key Question**

Does an animal that blends into its environment have a better chance of surviving from its predators than otherwise?

VI. **Background Information**

We know that certain organisms with certain traits have a better chance of surviving and reproducing. Charles Darwin called this "survival of the fittest". Those organisms that survive and reproduce, pass on the traits to their offspring that will enable them to survive. Through this natural selection process only the organisms that are best suited to their environment survive.

One of these natural selection adaptations is the coloration of an animal. Certain insects, birds, reptiles, and land animals have natural color patterns that enable them to blend into their environments. Some examples are polar bears, deer, chameleons, meadow larks, pheasant, frogfish, pipefish, treehoppers, and dead leaf mantis. This special coloration has enabled each animal to survive.

VIII. **Procedure**

1. With a paper cutter, take a one inch strip off the length of each of the four pieces of colored tagboard. Use a paper punch and punch out 50 disks of each color.
2. Place one of the large pieces of colored board on the floor and spread 50 disks of each color over the board as evenly as possible.
3. There are three student functions: the counter, the safety man, and the timer-recorder.

   The experiment requires that the student-counter stand a minimum of two meters above the railroad board with the disks on the floor. The student-counter will be given ten seconds to count silently as many of the disks as he can see during that time limit. He counts them in succession, as indicated on Chart I. It is emphasized that the student-counter must stand at least two meters above the "field of prey" in order for the experiment to work effectively.

   The safety man makes sure that the student-counter does not fall off the bench, ladder, or whatever you use to maintain the proper height from the "field of prey". He may also ensure that the student-counter does not continue to scan the "field of prey" after the timer-recorder tells him to stop.

   The timer-recorder obviously works the time-clock for the ten second count and then he records on Chart I the number of disks spotted by the student-counter on each attempt. The three students rotate until each has completed all three tasks.

Scenerio: Tom (student-recorder) is standing upon a sturdy and strong chair above the railroad board ("field of prey"), but he is looking away from the "field of prey". John (safety man) is watching Tom to ensure he doesn't fall and that he doesn't look down on the "field of prey" until Norris (timer-recorder) tells him to start. Norris tells Tom, "Count the yellow disks when I say 'go'". Norris says "go" and Tom begins to count the yellow disks until Norris says "stop". Tom stops, looks away from the "field of prey", tells Norris the number of yellow disks he counted, and Norris records that number on Chart I. Norris then says, "Count the green disks when I say 'go'". Etc., etc.


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Observer
(counts silently as many disks as he is able to see)
Safety Person
(insures the safety of the counter)
2 meters
Disks
Railroad Board
Timer
(times for 1 sec. and records the number of prey counted by observer)

4. Once the data has been collected each student determines the percentage of disks counted on each attempt. The pattern should become obvious that the number of the same colored disks counted should be substantially lower than the different colored disks counted.

X. **Discussion**

1. Does the color of the background make a difference in the number of the disks, by color, that were counted? Why do you think this happened?
2. Did you know that the disks were supposed to be small animals living on the ground? Did you know that counting the disks during each trial was supposed to be a larger animal feeding on a smaller animal?
3. Can you see by the total of your results that the protection of blending with the background does help "disk animals" survive?
4. Does an animal that does blend into its background have a better chance of surviving? Might this be an example of natural selection?
5. Can you name some animals where the natural selection process might be at work? (You might have each student submit a report on an animal exhibiting some form of the natural selection process.)

If you do not wish to provide so much "leadership" in helping the students understand the natural selection concept you might simply ask the following questions:

a. What happened?
b. Why do you think this happened?
c. How might this relate to the survival of some species in our world?

XI. **Extension**

**Variation: "Birds and Worms"**

This simulation game is great for an outdoor experiment.

**Materials**

Green, red, blue, yellow and brown pipe cleaners.
Cut each pipe cleaner into thirds — bend into "worms".
Butcher paper (large sheets — 1 meter square)

**Procedure**

1. Scatter the "worms" in a specified area, in the grass, on the ground, etc.
2. Give the students names of birds (Robin, Thrush, Meadowlark, Bluebird, Flicker, Crow, etc).
3. One at a time call out the name of the bird. As each species is called, the "bird" (student), can "fly" out over the area where the worms were scattered and pick up the worm that first catches the "birds" eye.
4. As the birds return have them lay out the worms on the butcher paper in the order in which they were picked up.
5. Repeat this process until all the birds have had a chance to fly over the area.
6. Have the students consider the color sequence of the worms captured and placed on the paper.

**Discussion**

1. What trends or patterns appeared? (If the worms were scattered on grass, one would expect the "green worms" to be picked up at the end of the simulation game, rather than in the early flights.)
2. Is there any relationship between coloration and the usual habitat of the worms?
3. Might there be similar relationships for other animals?
4. What is the value of animal coloration?
5. Did it take the last birds to fly out a longer period of time to find their worms? What implications might this have towards survival of both the worms and the birds?


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I. **Topic Area**

Clothes as insulators

II. **Introductory Statement**

Humans have a limited temperature range at which they can exist. In winter survival situations maintaining body heat is a prime consideration. In this investigation students evaluate different types of body coverings to determine which are the best insulators.

III. **Math Skills**

a. Charting
b. Graphing
c. Subtraction
d. Rate Computation

**Science Processes**

a. Measuring Temperatures
b. Predicting & Estimating
c. Controlling Data
d. Variables
e. Recording Data
f. Interpreting Data
g. Applying & Generalizing

IV. **Materials**

Cans with plastic lids
Hot plate
Large pot
Ladle
Thermometers (calibrated to 100°C or 212°F)
Rubber bands
Various material samples
Glue

V. **Key Question**

What types of body coverings make the best insulators of body heat?

VI **Background Information**

Animals possess various adaptations that enable them to deal with changing environmental temperatures. Mammals, unlike lower forms of life, are able to generate heat within the body to maintain a stable body temperature. This heat is lost to the external environment when the surrounding temperature is lower than the mammal's body temperature. All mammals have a form of insulation to preserve their body heat in cold environments. Ocean mammals like whales and seals have thick layers of fat to protect them from the frigid temperatures of the oceans. Land mammals rely on body fur to keep them warm in the coldest winter air.

Cold blooded animals like reptiles are unable to maintain a constant body temperature internally as do mammals. Reptiles must use external cooling or heating sources to compensate for extremes in air temperatures. In cool temperatures reptiles seek the warmth of the sun while in hot temperatures they seek the coolness of shade or water. Because the body temperatures of cold blooded animals depend directly on air temperatures these animals require no insulating surfaces about their bodies.

Man is a mammal and thus requires an external body covering. Like all mammals man has some body hair but this hair is no longer thick enough to provide the needed insulation. Using his brain man has discovered various substitute body coverings to insulate his body. The history of clothing is the history of man's attempts at devising body coverings to maintain a constant body temperature. The modern moon walker's spacesuit serves the same purpose as did the cave dweller's animal skins centuries ago.

VII **Management Suggestions**

1. Have enough equipment for groups of three.
2. Each group should test their own material and then share their results with the rest of the class.
3. Pour the water for younger students and remind them not to touch the cans.
4. At least two 1-hour periods will be required.

VIII. **Procedure**

1. Prepare the insulated jars prior to doing the experiment.
2. Most of the material samples can be obtained at thrift stores at nominal costs.
3. Use the rubber bands to tightly secure the material samples around the cans. Cover the can tops as well. Glue can be used to secure the material to the plastic tops. Make a small hole in the plastic lid to insert the thermometer.
4. Have a large volume of hot water available to use during the experiment.


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## IX. What the Students Will Do

1. Show students the materials. Have them predict which are the best insulators. Have them rank them in order 1-10. Discuss their choices and reasons.
2. Each group has 1 can, 1 lid and one thermometer. Each student in the group will record the data on a chart.
3. One group should have a bare can to serve as a control experiment.
4. After filling the can with 400 ml. of boiling water cover the can and quickly insert the thermometer.
5. Record the initial temperature on the chart. Take readings every 5 minutes for 40 minutes. Record all readings on the chart.
6. Compute the amount of heat lost by subtracting final temperature from initial temperature.
7. Graph the results using a line graph to see if the temperature loss was constant. (straight line indicates constant heat loss)
8. Compute the rate of heat loss.
   $\frac{\text{\# of degrees lost}}{\text{\# of minutes}} = \text{\#of degrees lost/minutes}$
9. Compute time it would take boiling water to reach room temperature.

## X. Discussion

1. Share results of all experiments.
2. Rank the materials in terms of insulation quality.
3. Which material was best insulator? Which was best conductor?
4. Compare results to predictions.
5. What type of clothing should be worn in a really cold environment?
6. What are some drawbacks to these types of clothing? How could they be solved? (example — Might be too hot - wear layers of clothing)

## XI. Extension

1. Challenge students to create the ultimate insulator.
2. How do materials perform when wet:
3. Which color clothes would be best? (Paint cans and measure their ability to absorb solar energy.)
4. Redo the experiment without the lids and compare the results to the first set of results.

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# INSECT LAWN JUMPERS

I. **Topic Area**
Insect study

II. **Introductory Statement**
Students will discover some special characteristics that enable a grasshopper to survive in its environment.

III.

| **Math Skills** | **Science Processes** |
|---|---|
| a. Averaging | a. Measuring |
| b. Ratios | b. Observing |
| c. Graphing | c. Recording Data |
| d. Percents | d. Interpreting Data |
| e. Fractions | e. Applying & Generalizing |

IV. **Materials**
Meter sticks
Metric rulers calibrated to millimeters
Trundle wheel (if available)
Magnifying glasses
Marker chips
Balance scales with weights less than a gram or beam scales
Grasshoppers
Jars
Envelopes

V. **Key Question**
What is a grasshopper and how is it adapted to surviving in its environment?

Discrepant event: Demonstrate how far a man could jump if he had a grasshopper's jumping ability. (about 1/3 of a football field)

VI. **Background Information**
Grasshoppers are members of the Orthoptera order of insects. Like all insects they have 3 body sections (head, thorax, abdomen) and 6 legs. They also have a pair of antennas, 2 large compound eyes (thousands of small eyes in one sight organ) and most have 2 sets of wings. A grasshopper develops through an incomplete metamorphosis life cycle. A nymph (young insect) hatches from an egg and grows progressively larger over a period of about 50 days. Periodically, the nymph molts, sheds its hard external skeleton, to accomodate its increased body size. Grasshoppers have chewing mouth parts that they use to devour grass and other plants. Specimens can be captured in nets or on cool fall mornings simply by picking up by hand.

VII. **Management Suggestions**
1. Use an envelope to confine grasshopper on the scale.
2. Grasshoppers usually weigh less than a gram so partial gram weights are required if a beam scale is not available.
3. Use markers to mark where grasshoppers land on jump test. Measure the longest of 5 jumps.
4. The flight test is last because this is frequently the last time you see the grasshopper. Much estimating is used to measure the flights of escapees. Use the meter sticks or trundle wheels to make flight measurements. Children should work together to mark starting and ending points of flights.
5. In all situations caution the students to be careful in handling the grasshoppers. The legs come off easily.
6. Use the magnifying glasses to observe the body.
7. At least five or six 40-minute periods will be required.

VIII. **Procedure**
1. Brainstorm with the class about grasshoppers. Discuss the grasshopper and its relationship with its environment.
   Where does it live?
   What does it eat?
   What are its enemies?
   How does a grasshopper avoid being eaten?
   Instruct the students that they are to study the grasshopper to determine how it is especially suited to survive in its environment.
2. Hand out chart (see sample) and discuss how each measurement is to be done. (Specifically what units are to be used) Groups of at least 2 are good. Holding and measuring a live grasshopper requires more than two hands.

IX. **What the Students Will Do**
1. Students are given grasshoppers, charts, and rulers and begin investigating. Do all measuring and observing before conducting jump and flight tests. Also, do all except flight tests within the confines of a closed room. Only the flight test is done outside.
2. Class averages their results for all measuring categories.
3. Graphing:
   A. Line graph to see if there was a relationship between length of body and length of jump.
   B. Bar graph to show frequency of sizes (lengths)


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## X. Discussion

1. What is the average weight of your grasshopper?
2. What is the average length of your grasshopper?
3. How many compound eyes, legs, wings, and body sections should an average grasshopper have?
4. What is the average length of a grasshopper's front leg?
5. What is the average length of a grasshopper's hind leg?
6. About how many times longer is the hind leg than the front leg of a grasshopper?
7. What is the average length of a grasshopper's longest leap?
8. What is the average length of a grasshopper's longest flight?
9. What colors were most of the grasshoppers?
10. Did long grasshoppers jump farther than short grasshoppers? Why or why not? (Test results probably won't prove this.)
11. Did heavy grasshoppers jump farther than light grasshoppers? Why or why not? (Test results probably won't prove this.)
12. Do grasshoppers have protective colorations? Explain your answer.
13. Do grasshoppers fly farther than they jump? If so, how much farther?
14. What determines whether a grasshopper flies or jumps?
15. How far could you jump if you had a grasshopper's jumping ability?

$$\frac{\text{length of longest flight}}{\text{length}} \times \text{your length} = \text{length of your jump if you had a grasshopper's jumping ability}$$

16. The abdomen is what fractional part of an insect's body?
17. The head is what fractional part of an insect's body?
18. The thorax is what fractional part of an insect's body?
19. How much would 50 grasshoppers weigh?
20. How many leaps would it take a grasshopper to cover 100 meters?
21. How is a grasshoppers hind leg different from yours? How is it especially useful to the grasshopper?
22. How is a grasshopper's eye different from yours?
23. Describe a grasshopper's head. How do the parts help the grasshopper survive?
24. What special abilities does a grasshopper possess that helps it avoid being eaten? (Brown substance released when held)
25. What other special body parts or abilities does a grasshopper have that help it survive in its environment? (claws, wings, legs, chewing mouth, etc.)

## XI. Extension

1. Draw a detailed picture of a grasshopper labeling as many body parts as possible.
2. Write a report describing an average grasshopper.
3. How are crickets and grasshoppers different and alike?
4. How do injuries affect a grasshopper's ability to survive?
5. How does temperature affect a grasshopper's jumping ability?



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# PREDATOR vs. PREY

I. **Topic Area**
Protective coloration and animal survival

II. **Introductory Statement**
Students will learn the importance of protective coloring and how animals use their senses.

III. **Math Skills**
a. Graphing
b. Averaging

**Science Processes**
a. Collecting & Organizing Data
b. Making Inferences
c. Observing

IV. **Materials**
Various colored pipe cleaners
Blindfold

V. **Key Question**
How does protective coloration contribute to the survival of animals in the predator-prey relationship.

VI. **Background Information**
In nature we think of two basic types of animals. Those that eat plants (herbivores) and those that eat other animals (carnivores). Animals whose survival depends on locating and capturing other animals must have highly developed senses, especially that of hearing and smelling. Animals which are the determined prey have a variety of assets to help their survival. Perhaps the greatest of these is their natural coloration which helps them blend into their surroundings. Animals that are not easily seen have greater chance of escaping detection and capture. Those animals which can best survive will pass on these protective devices to their young. This process of natural selection produces an animal who is ideally suited to his environment.

VIII. **Procedure**
1. Mark off a small area (size depends on number of students) in which to hide your animals (colored pipecleaners). Explain to the students that they are now predators who have to find their prey. Give the students 30 seconds to find all the food they can and bring it back to you. Chart how many of each color was returned.

| | GREEN | WHITE | BLACK | ORANGE | BROWN | RED | YELLOW |
|---|---|---|---|---|---|---|---|
| Beginning number | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Number returned | 6 | 3 | 4 | 10 | 2 | 8 | 10 |
| Difference (Survival) | 4 | 7 | 6 | 0 | 8 | 2 | 0 |

X. **Discussion**
1. What color was most frequently brought back?
2. If you were the prey, what color would you like to be?
3. What are some types of animals we might see in the forest that are orange? green? brown? etc.
4. Why do you think that we do not find many brightly colored animals in the forest?

XI. **Extension**
Students stand in a circle. One person is selected to be prey. Another student is selected to be the predator. The predator is blindfolded so that he must rely on his senses to catch his dinner. Both predator and prey are releasesd within the standing circle and a chase ensues. Both "animals" must stay within the circle. Students in the outer ring must be quiet so all the senses can be sharpened. They are also responsible for the safety of the blindfolded predator. When the predator approaches the outer circle, students are to reach out and "touch" him so that he knows his limits. Time span for each pair should be determined by the supervisor.

Note: Try to select an area that is relatively flat and free from obstacles.

**Discussion Questions:**
A. Who was the most effective predator? Why? What type of movement pattern did he use?
B. Who was the most effective prey? Why? What techniques can prey animals use to survive?
C. How much was luck involved on the part of both animals?
D. Summarize the factors that determine successful survival.

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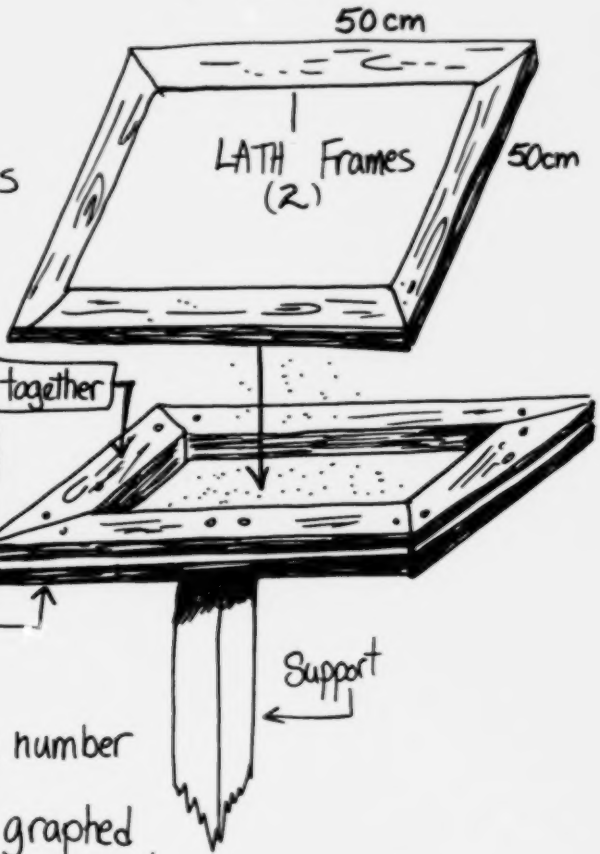
# WHAT's in the AIR ?

NAME _____

1. Using the lath pieces, make frame approximately 50cm X 50cm.
2. Using the felt tip pen, mark the graph paper into any sample size area that you wish to sample (i.e. 10cm² sections or 1cm² sections.).
3. You may use the included master if you wish.
4. Place the graph paper between 2 sheets of contact paper both sticky sides up so that the graph paper is securely held in place.
5. Staple (thumbtack/nail) the "contact plate" to the lath frame. Add a support.
6. Select several different locations to display the plates.
7. Check the plates daily and fill out the What's in the Air? Chart. Use radio, T.V. & newspapers for weather data.
8. Examine the amount of pollutants from 4 random squares. Use the sample grid coordinates (squares) each day. Count the number of pollutants in each grid and record the average number of pollutants on the chart.
9. Results may be quantified and graphed based on location, weather conditions, and amount of pollutants that were recorded over a period of time.



_____ (Name)

# WHAT's in the AIR ?

Plate# _____ Location _____

Names of Monitors _____

| Date | Time | Wind Direction/ Speed | Temp. | Weather Conditions | Average# of Pollutants | Grid Coordinates for 4 squares | | | | Monitor's Initials |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
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Comments/Observations: _____

_____

_____

_____

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# * Bottled Pollution * Table 1

NAME _____

JAR# _____ LOCATION: _____

NAME(s) of MONITOR(s) _____

| DATE | TIME | WIND SPEED/DIRECTION | TEMP. | WEATHER CONDITIONS | OBSERVATIONS | MONITOR'S INITIALS |
|---|---|---|---|---|---|---|
| | | | | | | |
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Date from_____to_____ Total # of days_____

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# * Bottled Pollution *

NAME _____

Table 2

After 30 days:
1. Bring in the 3 jars and label 3 pans to match
2. Measure the mass of each empty pan and record.
3. Pour the water from jar 1 into pan 1 and place on a heat source.
4. Carefully evaporate all water - Repeat for jars 2 & 3. You may need to rinse each jar with additional distilled water until all material is collected and transfe to the pan.
5. Measure the mass of the pan with the dust. Subtract the mass of the pan alone and you have the amount of dust in milligrams. This is the amount of dust collected in 30 days per surface area of your jar. Surface area (mouth) $= \pi r^2 = 3.14 \times r \times r$

| | Mass of Pan with Pollutants | − Mass of Empty Pan | = Mass of Pollutants in Milligrams |
|---|---|---|---|
| **Pan #1** | | | |
| **Pan #2** | | | |
| **Pan #3** | | | |

Comments & Observations:

_____

_____

_____

_____

_____

_____

_____

Diameter of jar _____ ÷ 2 = _____ radius X _____ radius = _____ $r^2$ X ($\pi$) 3.14 = _____ surface area of jar's mouth.

Mass of dust (mg) _____ ÷ _____ surface area of jar X 2.8 (conversion factor) = _____ tons of dust per square mile per month.

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NAME

# WHITE RAIN

How much water does your sample of snow produce?

| | | |
|---|---|---|
| A. | Volume of sample | |
| B. | Initial temperature of snow sample | |
| C. | Water volume estimate | |
| D. | Final water Volume | |
| E. | Percentage of Error $\frac{\text{Difference CD}}{D}$ | |
| F. | Percentage of Volume loss $\frac{A-D}{A}$ | |
| G. | Ratio of snow Volume to water Volume $\frac{A}{D}$ | |

I. General condition of snow sample: _____

J. Strain the melted sample through clean filter paper. Record your observations.

. Place the container on a heat source. Record the temperature of the snow at 1 minute intervals as the snow melts. Take readings for 5 minutes after the snow melts.

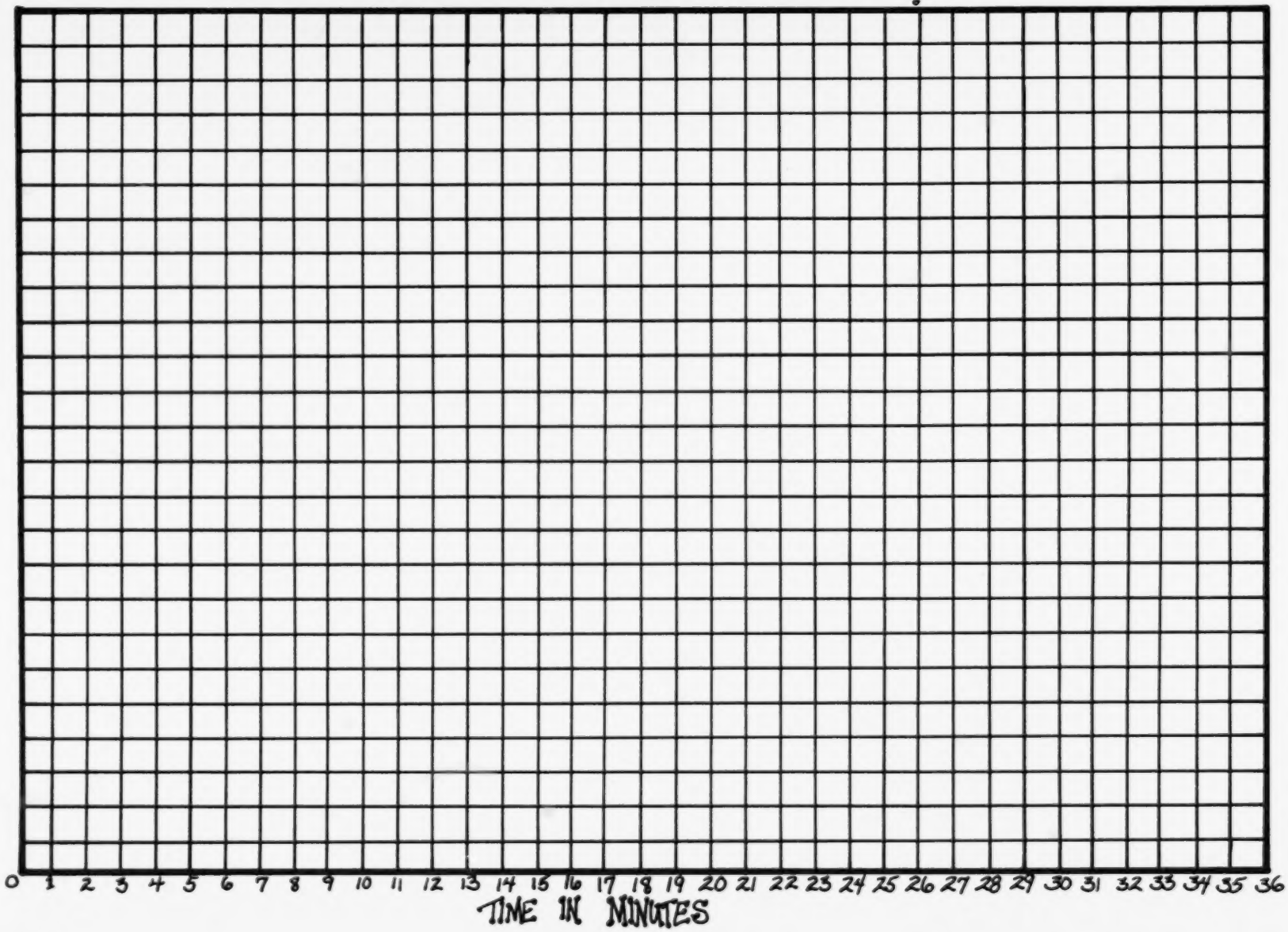
H.

| Time | Temp. | Time | Temp. | Time | Temp. |
|---|---|---|---|---|---|
| 0 min. | | | | | |
| 1 | | 11 min. | | 21 min. | |
| 2 | | 12 | | 22 | |
| 3 | | 13 | | 23 | |
| 4 | | 14 | | 24 | |
| 5 | | 15 | | 25 | |
| 6 | | 16 | | 26 | |
| 7 | | 17 | | 27 | |
| 8 | | 18 | | 28 | |
| 9 | | 19 | | 29 | |
| 10 | | 20 | | 30 | |

# WHITE RAIN

NAME _____

TEMPERATURE/TIME

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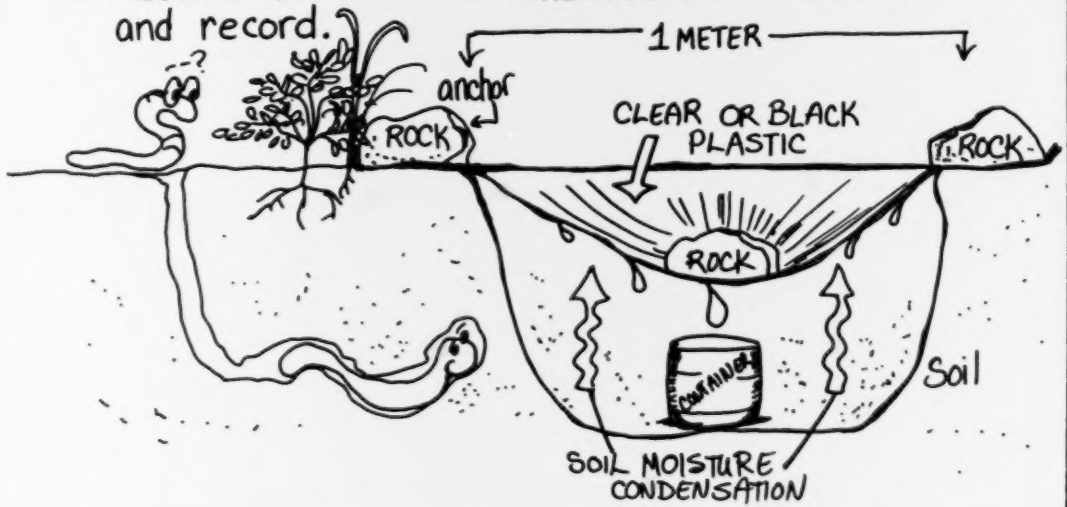
# WATER STILL on the HILL

NAME _____

How much water can you squeeze from the sun?

1. Dig a hole in the soil, 1 meter in diameter.
2. Place a container at center bottom of the hole.
3. Cover the hole with a black plastic sheet. Let the plastic sag in the middle over the container but not touching.
4. Place a rock at the bottom center of sag.
5. Anchor the sheeting with rocks or soil around the top.
6. Measure the amount of condensed water collected and record.




| TIME | BLACK PLASTIC | CLEAR PLASTIC | CLOTH | METAL SHEET |
|---|---|---|---|---|
| NOON | | | | |
| 3:00 P.M. | | | | |
| 6:00 P.M. | | | | |
| 9:00 P.M. | | | | |
| MIDNIGHT | | | | |
| 3:00 A.M. | | | | |
| 6:00 A.M. | | | | |
| 9:00 A.M. | | | | |

7. Repeat the investigation several times using clear plastic or other materials at day and night hours.

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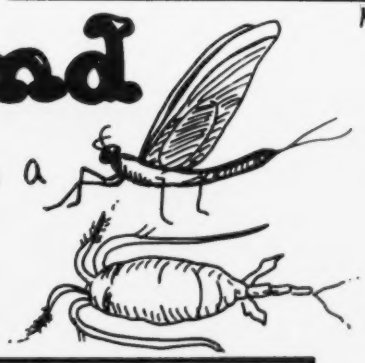
NAME _____

# On Living Pond

What types of organisms might be found in a freshwater pond community?



## ANIMAL CLASSIFICATION

| | A. | B. | C. | D. | E. | F. |
|---|---|---|---|---|---|---|
| GROUP 1 | | | | | | |
| GROUP 2 | | | | | | |
| GROUP 3 | | | | | | |
| GROUP 4 | | | | | | |
| GROUP 5 | | | | | | |
| GROUP 6 | | | | | | |
| TOTALS | | | | | | |
| PER CENT | % | % | % | % | % | % |

TOTALS OF COLUMNS A-F _____ labeled X.

FIND THE % OF EACH ANIMAL FOUND BY ÷ THE TOTAL FROM EACH COLUMN BY X. Ex. column A ÷ X = %

## PH/TEMPERATURE SAMPLINGS

P* Prediction A* Actual

| Location of Sample | Time | PH TEST P* | PH TEST A* | TEMPERATURE AIR P* | TEMPERATURE AIR A* | TEMPERATURE WATER P* | TEMPERATURE WATER A* | GENERAL WEATHER CONDITIONS: |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
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# On Living Pond – VOLUME

NAME _____

How many gallons of water are in the pond?

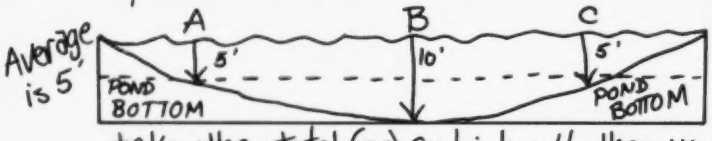
**A** Find the average diameter (distance across) of the pond. Measure the length and width - take several measurements to find the average.

Av. Pond width _____ ft.
Av. Pond length _____ ft.
Total _____ ft. ÷ 2 = _____ ft. average diameter
Average diameter _____ ft. x 3.14 = _____ ÷ 4 = _____ sq. ft. surface area of pond

**B** Find the average depth of the pond. Measure the depth in 3 places along a line (transect) across the pond as near the middle as possible. Add these depths and divide by 4 to get the average depth.

First measurement _____
Second measurement _____
Third measurement _____
Total _____ ÷ 4 = _____ average depth

* The reason that you take 3 measurements then divide by 4 is to allow for the shallow areas of the pond. (See drawing) If the depths were A(5'), B(10') & C(5'), total (20'); 20 ÷ 3 would be 6⅔' for an average. But, the actual average is 5'. If you take the total (20) and ÷ by 4, then you get the correct average of 5'.




**C.** FORMULA for computing number of gallons of water in the pond.

1. _____ (Area of pond) x _____ (Average Depth) = _____ (Volume in cubic ft.) cub. ft.
2. _____ (Volume in cub. ft.) cub. ft. x 7.48 = _____ (# Gallons of water in pond) gallons

A cubic ft. of water is in a container 1 ft wide, 1 ft. high, & 1 ft. long and contains 7.48 gallons

**D.** Formula for computing the volume using acre feet

1. (Surface) _____ (Area of pond in ft.) x _____ (Av. depth in ft.) = _____ (Volume of Cubic ft.)
2. _____ (Volume cubic feet) ÷ 43560 (sq. ft. in an acre) = _____ (Acre ft. of water)
3. _____ (Acre ft.) x 395,900 (Gallons/acre ft.) = _____ (# Gallons in Pond)

If the average person uses 200 gallons of water per day, how many people could live one day from this pond?



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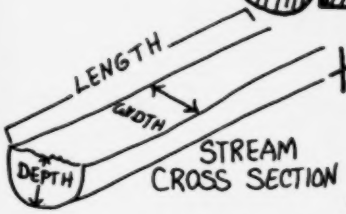
INVESTIGATOR _____

# GET with the FLOW




How much water is flowing past where we are standing?

1. At your stream, mark off 100 foot length by stretching string across the beginning and ending points where the investigation takes place.
2. Predict the time it will take a tennis ball to travel this distance.
3. Measure the time it takes the tennis ball to cover 100 feet and record.
4. Use the average time to compute the velocity.

VELOCITY

| | Prediction | Actual Time |
|---|---|---|
| Trial 1 | _____ sec. | _____ sec. |
| Trial 2 | _____ sec. | _____ sec. |
| Trial 3 | _____ sec. | _____ sec. |
| Trial 4 | _____ sec. | _____ sec. |
| Trial 5 | _____ sec. | _____ sec. |
| Total | _____ sec. | _____ sec. |
| Average | _____ sec. | _____ sec. |

$$\text{Velocity} = \frac{\text{feet traveled}}{\text{Time (sec.)}} = \text{feet per second}$$

$$\underset{\text{(Feet traveled)}}{100} \div \underset{\text{(Average time)}}{\text{_____ sec.}} = \underset{\text{(Velocity)}}{\boxed{\quad \text{ft/sec} \quad}}$$

5. **NEXT** - Measure width at 3 points, Average.

_____ ft. + _____ ft. + _____ ft. = _____ ft. ÷ 3 = ☐ ft. Average Width

6. **THEN** - Measure depth at 3 places, Average.

_____ ft. + _____ ft. + _____ ft. = _____ ft. ÷ 3 = ☐ ft Average Depth

VOLUME

7. Multiply average width x average depth x length (100 ft.) to find Volume.

$$\underset{\text{(width)}}{\text{_____}} \times \underset{\text{(depth)}}{\text{_____}} \times \underset{\text{(length)}}{\frac{100\text{ft.}}{}} = \boxed{\quad \text{ft.}^3 \quad} \text{ VOLUME}$$

8. Calculate SECOND FEET FLOW (cubic feet per sec.) by the formula

Second Feet Flow

$$\frac{\text{Volume (w x d x l)}}{\text{Time (sec.)}} = \text{Second Feet Flow}$$

$$\underset{\text{(Volume)}}{\text{ft.}^3} \div \underset{\text{(Average time)}}{\text{_____ sec.}} = \underset{\text{(Second Feet Flow)}}{\boxed{\quad}} \text{ cubic ft. per second}$$



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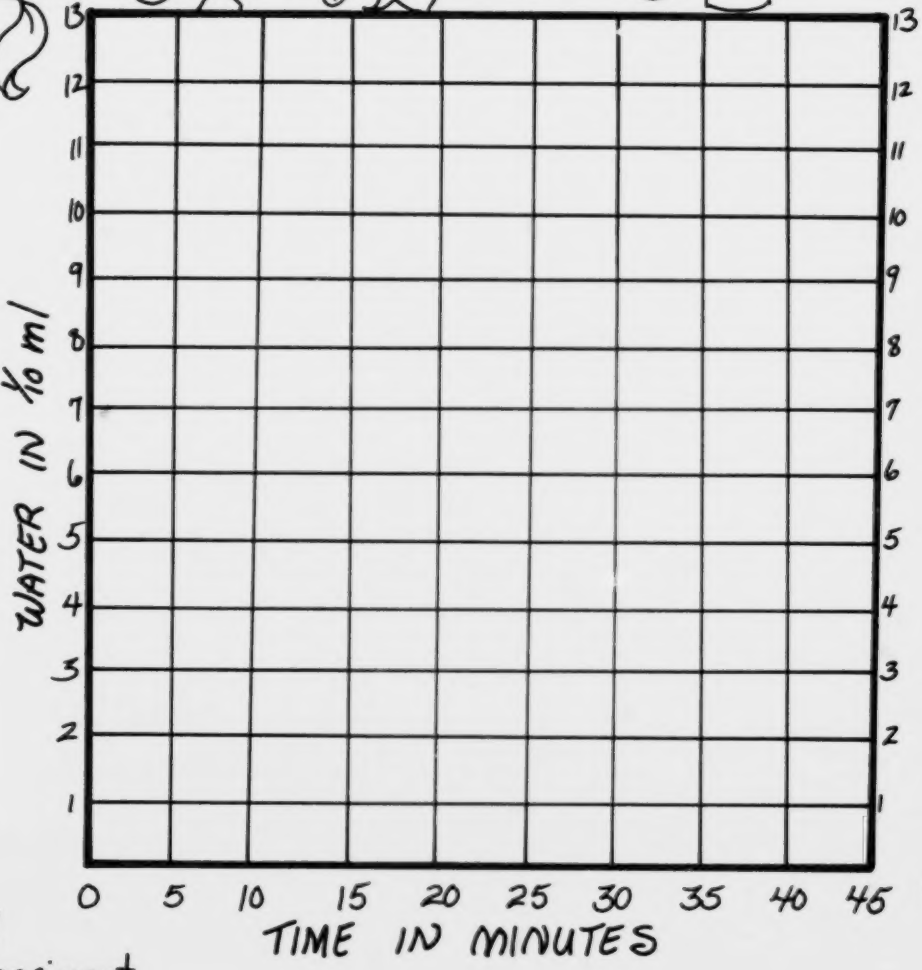
BOTONIST

# TRANSPIRATION

## Why Are Plants So Thirsty?

1. Record the level of water
2. Take readings every 5 min. until 8 are recorded.
3. Next begin fanning the leaves and take 8 more readings.
4. Loosely cover the plant with a plastic bag. Take 8 more readings.

| | TIME | SHOOT UNCOVERED | SHOOT FANNED | SHOOT COVERED |
|---|---|---|---|---|
| | 0min | | | |
| 1. | 5min. | | | |
| 2. | 10min. | | | |
| 3. | 15min. | | | |
| 4. | 20min. | | | |
| 5. | 25min. | | | |
| 6. | 30min. | | | |
| 7. | 35min. | | | |
| 8. | 40min. | | | |




5. Make a line graph of your results. Use colored lines for each of the 3 phases of the experiment

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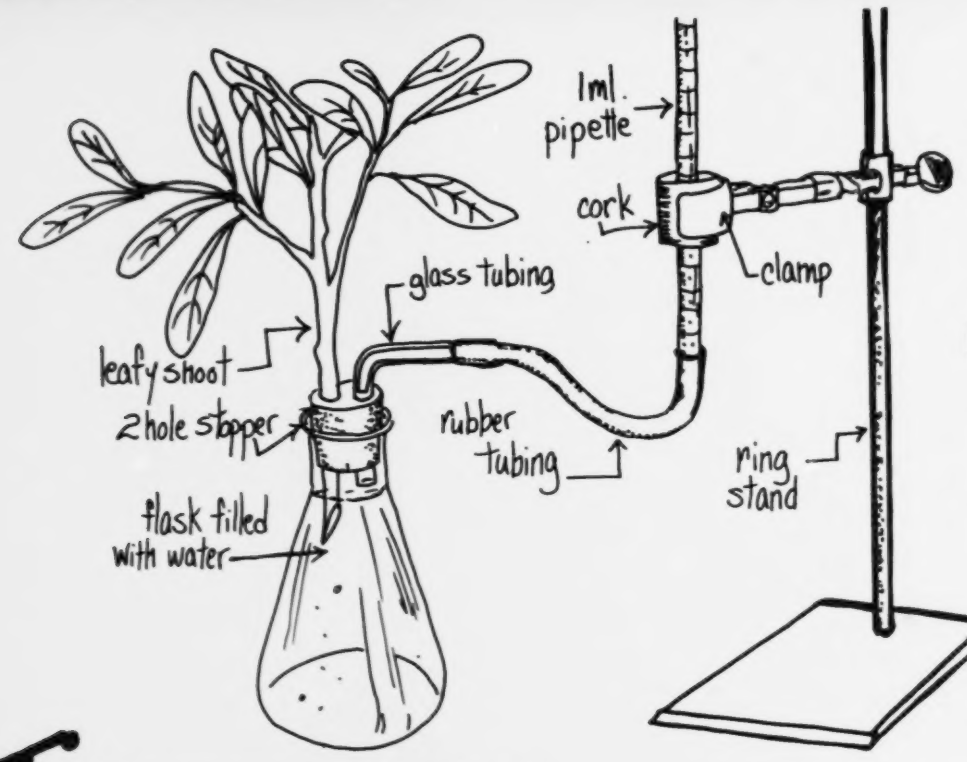
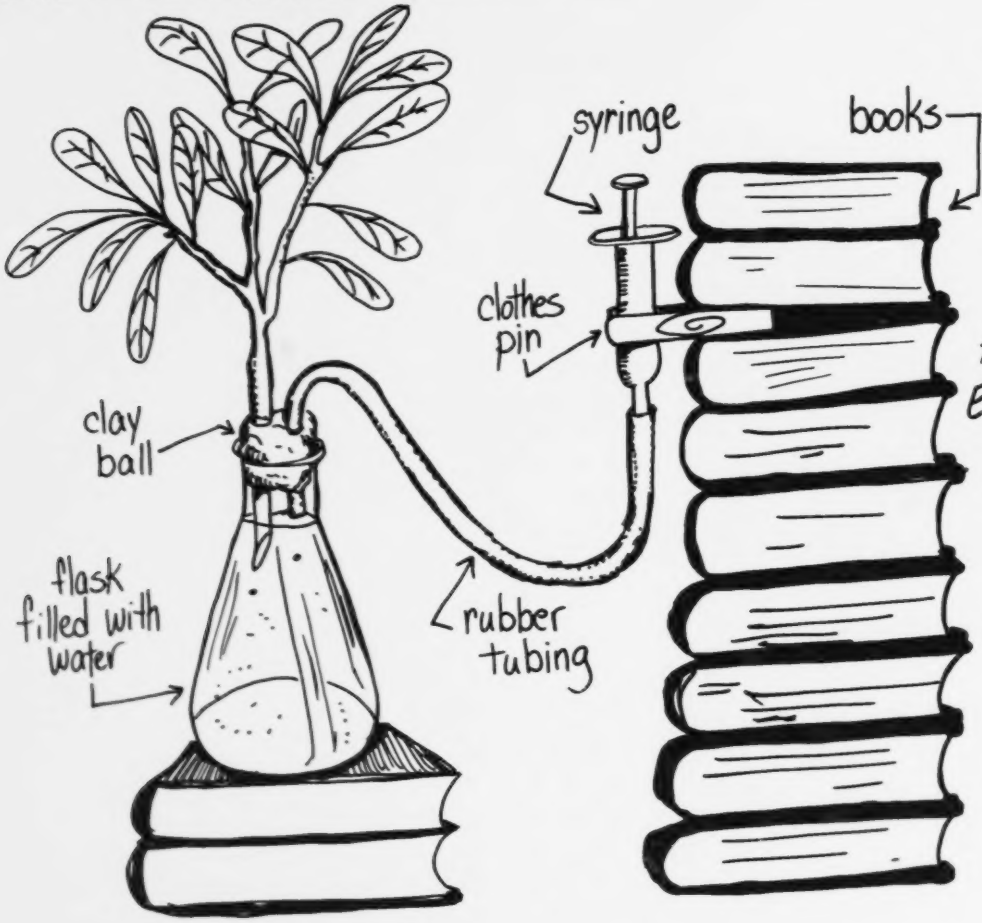



EQUIPMENT DIAGRAM

# TRANSPIRATION




ALTERNATE EQUIPMENT DIAGRAM

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# THIRSTY GREENS

NAME _____

Select a small branch with several leaves and cover each leaf with a plastic bag. Record the time covered. Find the surface area of the leaf by measuring the length and width or with a cm grid. Place a pebble in the bag to force the bag to droop so moisture can be collected. Secure with a rubber band. When results are visible, record the time, uncover and measure the amount of water in a graduated cylinder. Record results.

| NAME / LEAF DRAWING | WIDTH | LENGTH | AREA | START TIME | FINISH TIME | TOTAL TIME | AMOUNT OF WATER | AMOUNT $H_2O$ PER DAY | AMOUNT $H_2O$ PER YEAR |
|---|---|---|---|---|---|---|---|---|---|
| | cm | cm | $cm^2$ | | | | | | |
| | cm | cm | $cm^2$ | | | | | | |
| | cm | cm | $cm^2$ | | | | | | |
| | cm | cm | $cm^2$ | | | | | | |
| | cm | cm | $cm^2$ | | | | | | |

# of leaves on branch:
A. _____

# of branches on plant:
B. _____

Approximate # of leaves per plant; A x B:
C. _____

Amount of water from 1 leaf in 1 day X C equals amt. of water from whole plant in 1 day.
_____

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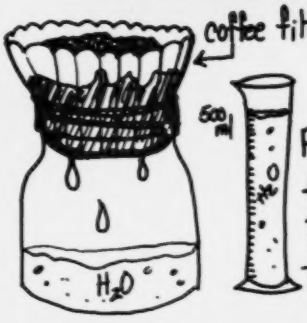
NAME _____

# DISAPPEARING DRIPS

How much water ($H_2O$) can soil retain before it becomes saturated?



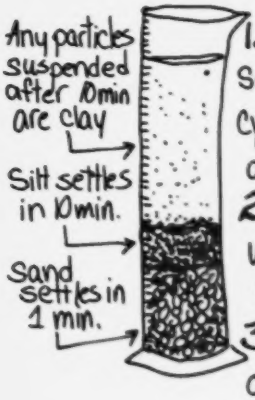

Place soil sample in a coffee filter. Find mass. Record. Place the soil filled filter on top of a jar. Pour in 500ml of water. Let drain. Pour water in jar back into graduated cylinder and remeasure. to find the amount of water absorbed by the dirt.

(X) (A) (B) (A-B) (Y) (Y-X=Z) (Z÷Y=%)

| Type or Location Description of sample | Sample Mass g | ml Water Added | ml Water Recollected | ml Water Absorbed | Saturated Soil Mass | Water mass in Soil | % of Water in Soil |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

## EXTENSION: COMPOSITION of SOIL SAMPLE

(X) (A) (A÷X) (B) (B÷X) (C) (C÷X)

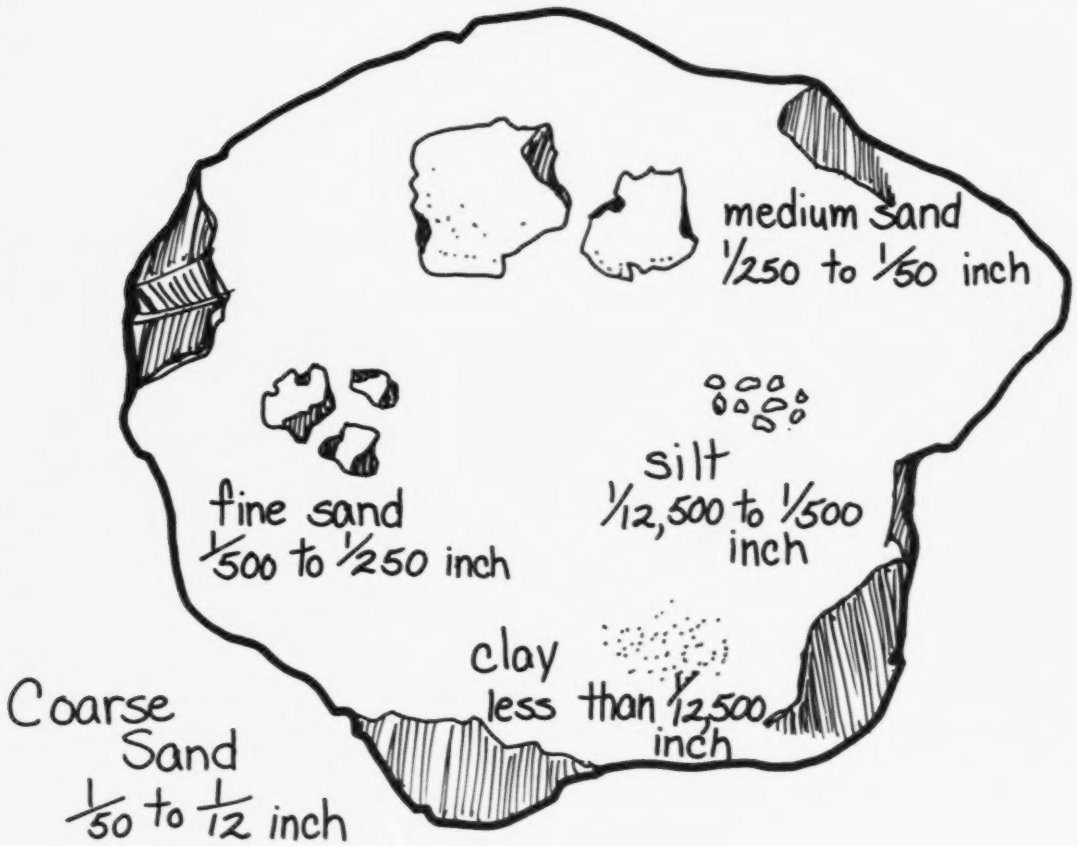



1. Place soil sample in graduated cylinder. Record amt. of soil.
2. Fill cylinder with water and shake.
3. Record ml of settled soil after 1 and 10 min.

| TOTAL SAMPLE | SAND (in 1 min.) | | SILT (in 10 min.) | | CLAY (over 10 min.) | |
|---|---|---|---|---|---|---|
| | ml | % | ml | % | ml | % |
| | | | | | | |
| | | | | | | |
| | | | | | | |

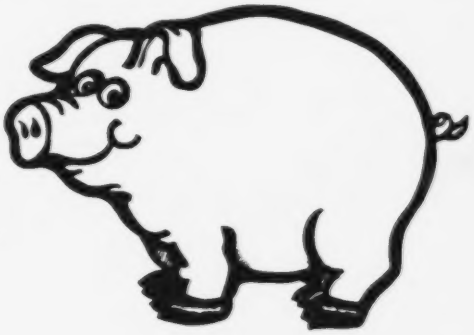
# Discovering Dirt

## SOIL PARTICLES

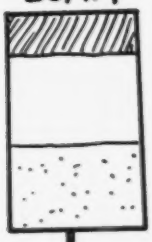


# Discovering Dirt

## MASTER SOIL CHART

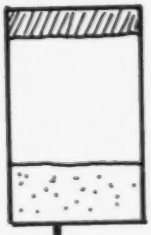


**LOAM**



clay 20%
silt 40%
sand 40%

**SILT LOAM**

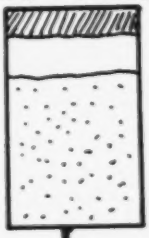


clay 15%
silt 60%
sand 25%

**SILT**

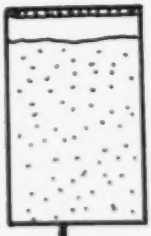
clay 5%
silt 85%
sand 10%

**SANDY LOAM**



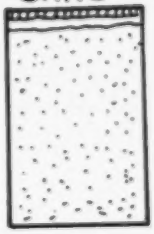
clay 10%
silt 20%
sand 70%

**LOAMY SAND**



clay 5%
silt 10%
sand 85%

**SAND**



clay 2%
silt 3%
sand 95%

**CLAY LOAM**

Clay 35%
silt 35%
sand 30%

**CLAY**

clay 60%
silt 20%
sand 20%

NAME _____

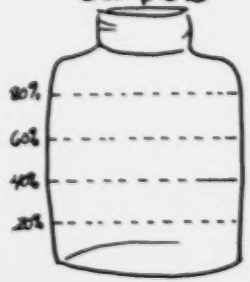
# Discovering Dirt

| | B. DEPTH OF SAND LAYER | B÷A % SAND | C. DEPTH OF SILT LAYER | C÷A % SILT | D. DEPTH OF CLAY LAYER | D÷A % CLAY | A. TOTAL DEPTH OF SEDIMENT | TYPE OF SOIL |
|---|---|---|---|---|---|---|---|---|
| **Sample A** | | | | | | | | |
| **Sample B** | | | | | | | | |
| **Sample C** | | | | | | | | |

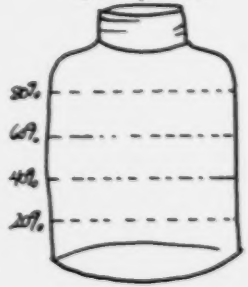
1. Fill jars 2/3 full of water.
2. Pour soil into jar until water is almost to top.
3. Place lid on jar and shake vigorously until all soil is suspended.
4. Wait 24 hours.
5. Observe layers of sediment. Measure the total depth of sediment and depth of each layer. Record on chart.
6. Compute percentages
7. Classify the sample by comparing its percentages to the Master Soil Chart.

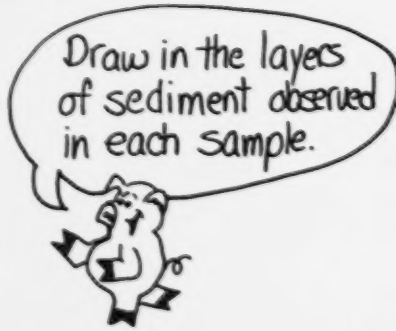
Sample A

Sample B




Sample C

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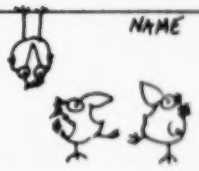
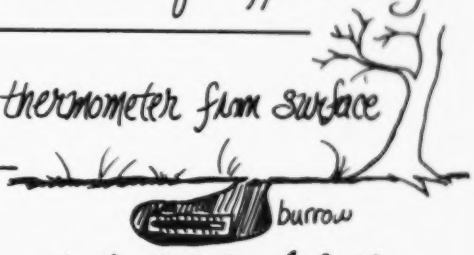
# Habitat Comparisons

NAME _____



1. Lay your thermometer on top of the ground and leave it for approximately three minutes. Record the temperature. _____

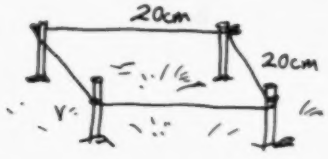
2. Dig a burrow, a hole, deep enough to hide the thermometer from surface light. Record the temperature. _____

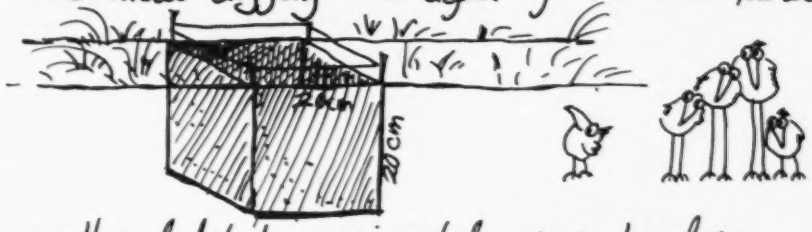



3. Using PH paper or soil test kit, measure and record the PH level of the surface soil and the soil from the bottom of the burrow (hole).
PH surface soil _____ PH burrow soil _____

| PH Chart | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Very Acid | | Moderately Acid | | | | Neutral | | | Moderately Alkaline | | | Very Alkaline |

4. Measure out a 20 cm. square on the surface and line off the area. Separate grass, sticks, insects, roots or other organic or inorganic material into pie pans and count the amount of material you have of each. Continue to do this while digging to a depth of 20 cm. Record.




5. Repeat the steps in another habitat assigned by your teacher.

| | Brief Description | Surface PH | Burrow PH | Surface Temp. | Burrow Temp. | Root # | Dead Plant Material | Animals Bugs Insects | Large Twigs etc. | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Area #1 | | | | | | | | | | |
| Area #2 | | | | | | | | | | |



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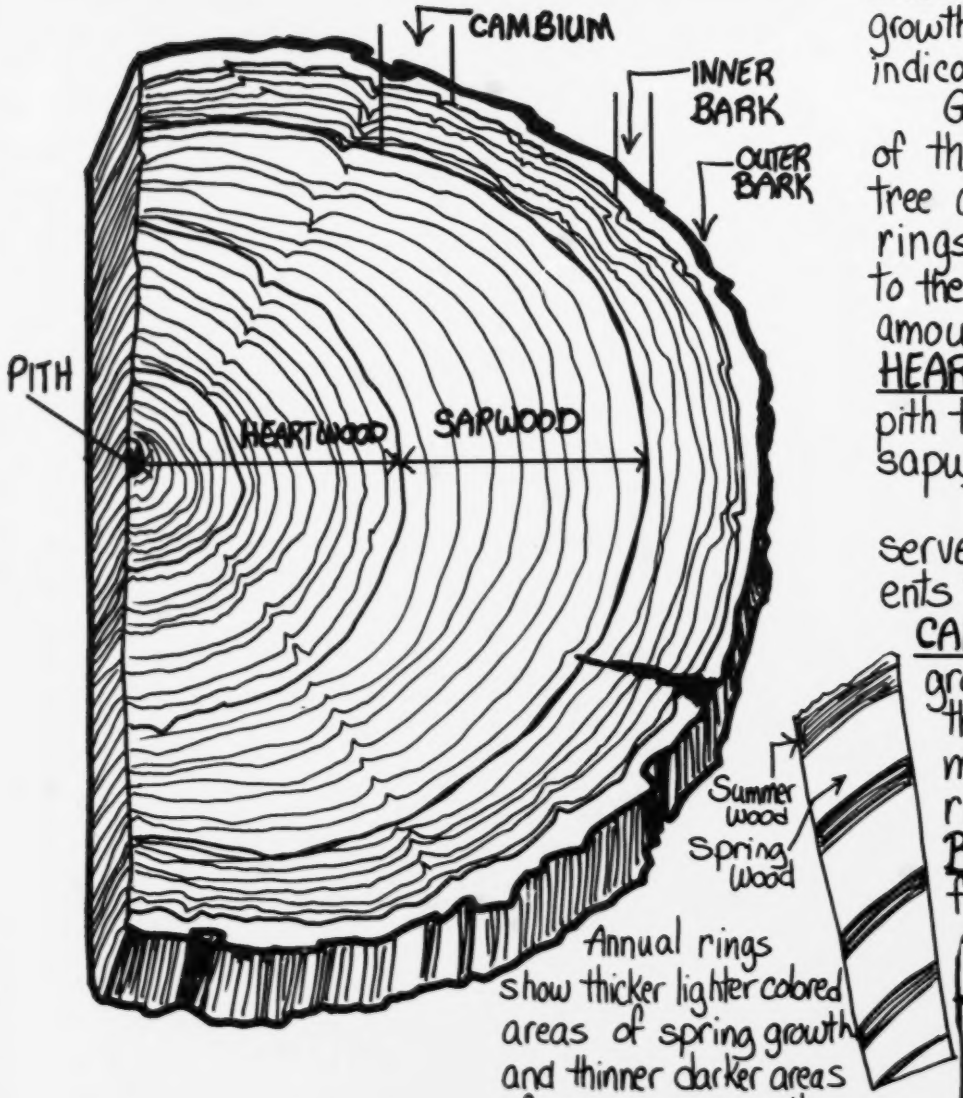
# TREE COOKIES

NAME

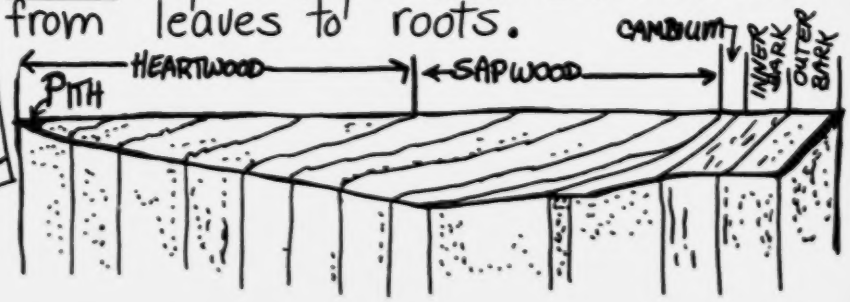
Counting tree rings gives a fairly accurate account of a tree's age. The wider the rings, the more growth, indicating ideal growth conditions. The narrower ring indicates less growth due to drought or cold cycles.

Growth occurs in a small microscopic layer of the tree called the **CAMBIUM**. The other parts of the tree are basically dead. The **PITH** is the center of the rings. Its position, whether in the exact center or off to the side can indicate growth factors such as the amount of shade from surrounding foilage. The **HEARTWOOD** is the darker area surrounding the pith that consists of closed up capillary passages. This former sapwood now serves as the fortification of the tree.

The next layered section is the **SAPWOOD** which serves as the transportation system for fluids and nutrients to pass up the tree to outer branches and leaves. The **CAMBIUM** layer is next, as it produces cells, the tree grows. The inner cells become **SAPWOOD** while the outer cells become the **INNER BARK**. This moist layer will dry and help replace the rough exterior or **OUTER BARK**. The **INNER BARK** helps transport fluids down the tree from leaves to roots.




Annual rings show thicker lighter colored areas of spring growth and thinner darker areas of summer growth.





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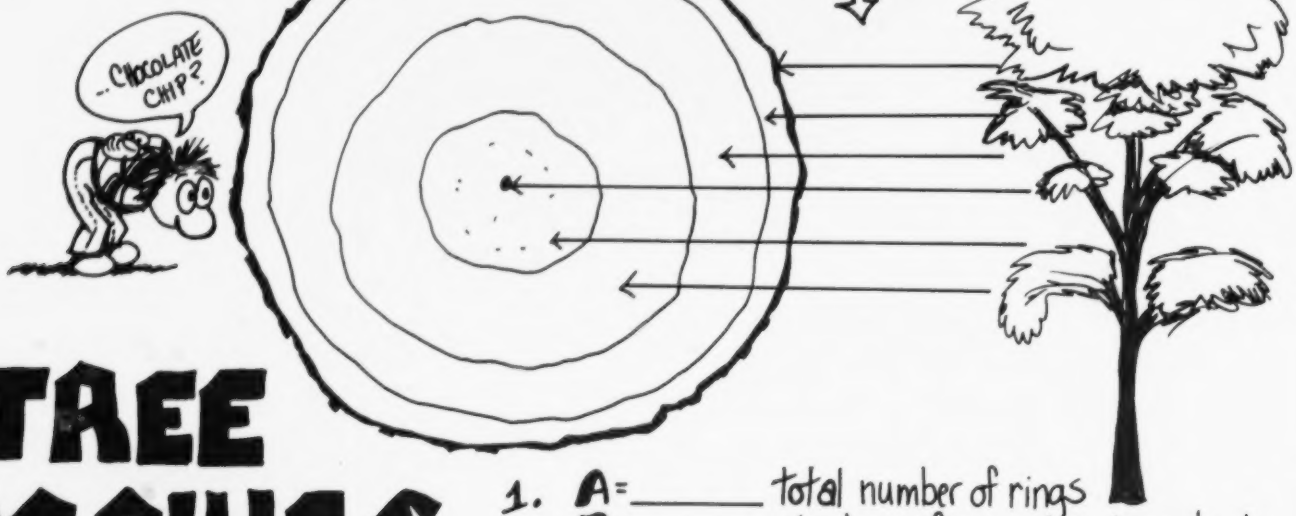
NAME _____




# TREE COOKIES

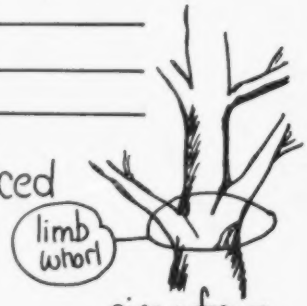
1. **A**=_____ total number of rings
   **B**=_____ distance from pith to inner bark
   **C**=_____ distance from pith to 10th ring
   **C ÷ B**=_____ percent % of growth in 1st decade

2. Measure to see if pith is in the center. If it is not, what might be some reasons why? _____

_____

_____

3. Choose a tree. Count the number of whorls produced by lateral buds. _____ number of whorls




4. Measure the circumference of the tree at chest height. _____ circumference

5. Divide the circumference by 3.14 ($\pi$) to find the diameter. C ÷ 3.14

C=_____ ÷ 3.14 =_____ diameter

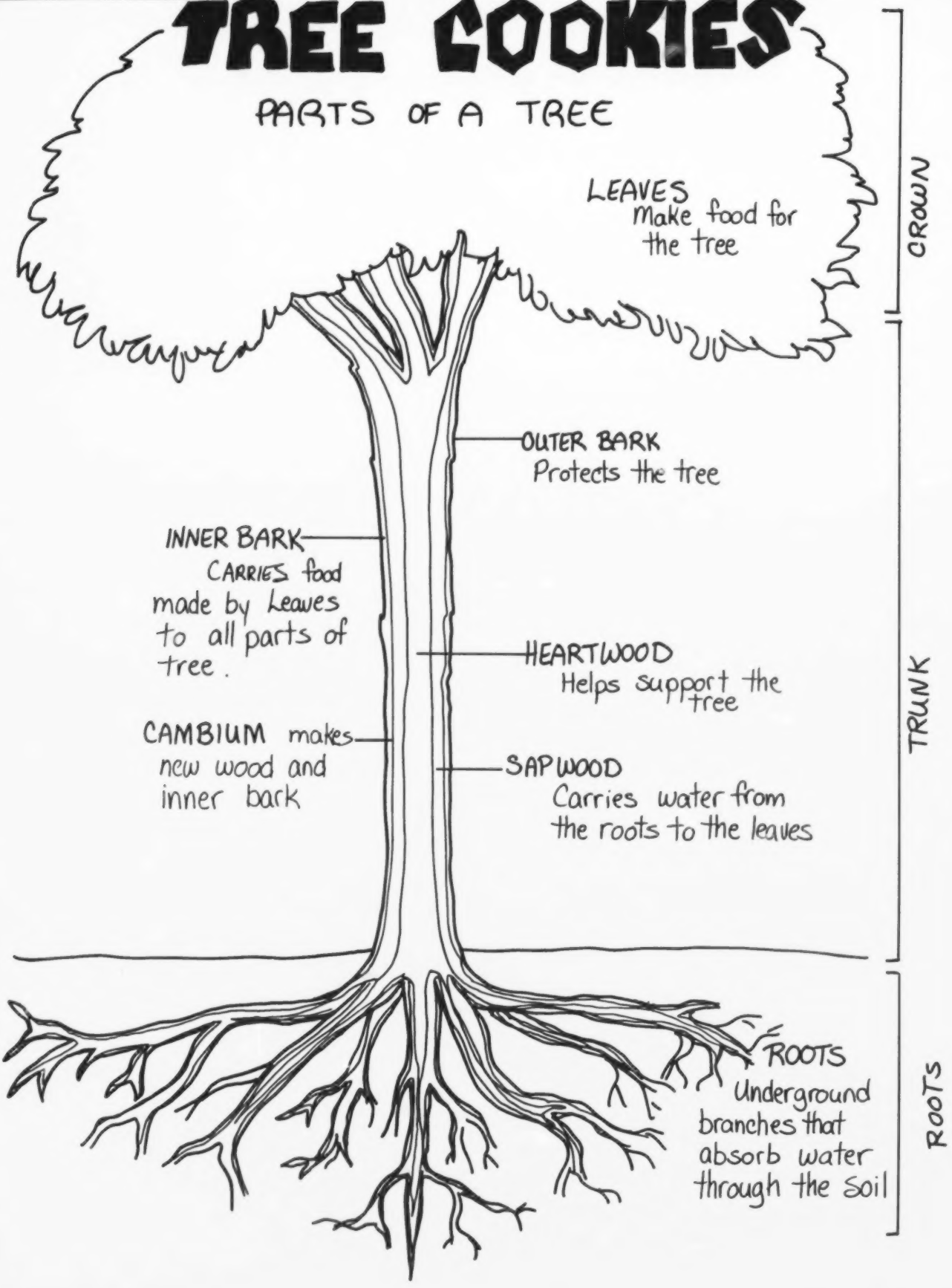
6. Screw increment bore in the distance of the diameter ÷ 2.
   diameter _____ ÷ 2 =_____ radius.

7. Count the number of rings in the increment sample. _____ #RINGS
   Age of tree _____
   Number of whorls _____ } Are these numbers close?

NAME _____

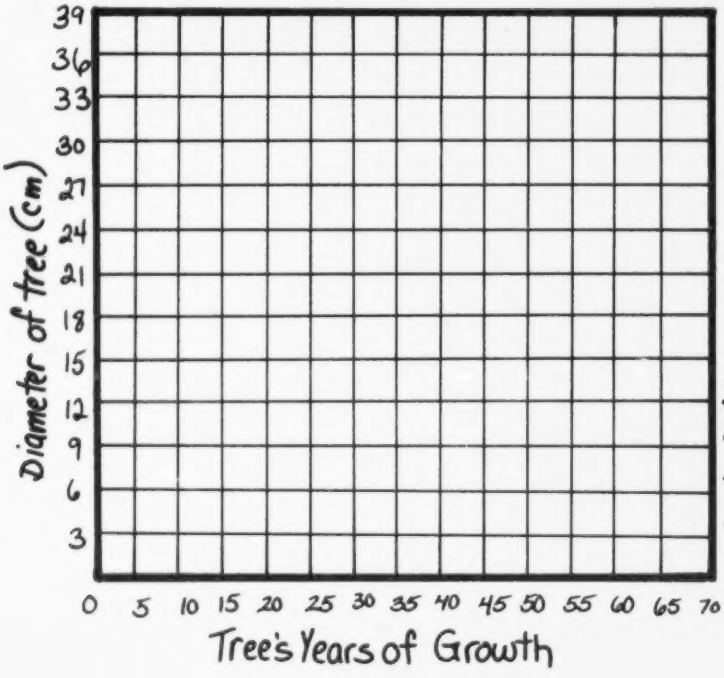
# TREE COOKIES

## PARTS OF A TREE



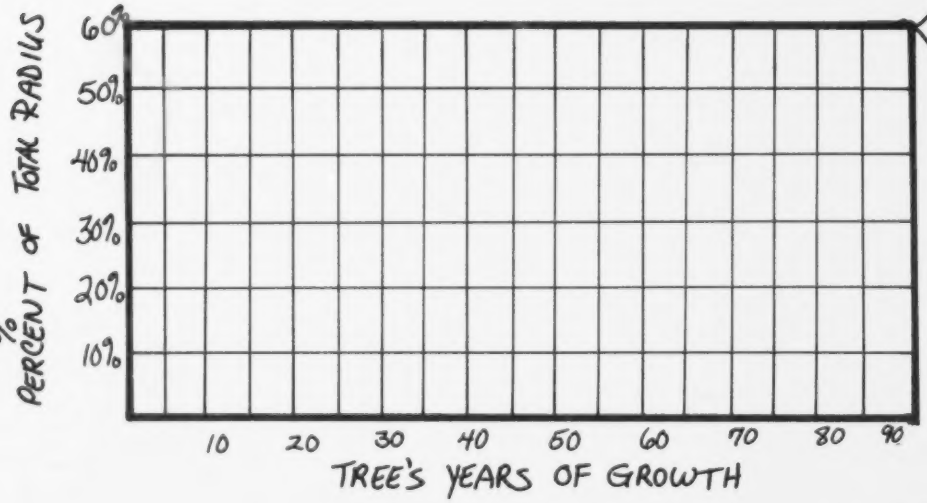
Name _____

# TREE COOKIES




Measure the rings marking off the decades

10yrs. ____ cm ÷ Radius = ____ % of Growth
20yrs ____ cm ÷ Radius ____ % of Growth
30yrs ____ cm ÷ Radius ____ % of Growth
40yrs. ____ cm ÷ Radius ____ % of Growth
50yrs ____ cm ÷ Radius ____ % of Growth
60yrs. ____ cm ÷ Radius ____ % of Growth
70yrs ____ cm ÷ Radius ____ % of Growth




Measure the circumference of some surrounding trees. Calculate the diameter and radius.

| CIRCUMFERENCE C | DIAMETER D | RADIUS R | C ÷ D = |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

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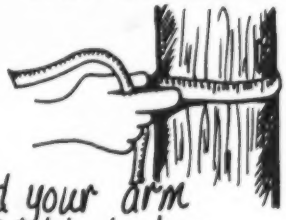
_____ NAME

# TREES as a CROP

How many board feet are in a tree?

**A.** At breast height, measure the circumference of a tree in inches.

_____ in. (Circumference) ÷ 3.14 (π) = _____ in. (Diameter)



**B.** Measure one chain (66') from the base of the tree. Extend your arm straight at shoulder height holding the biltmore stick. Sight to top of the tree. Record the number closest to your line of sight. The number is equal to the number of 16 ft. logs the tree has. _____ # of 16' logs

**C.** Use the Biltmore Chart to find board feet in the tree. Show calculations.

BILTMORE BOARD FEET CONVERSION CHART

| DIAMETER IN INCHES | # of 16 foot logs 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|
| 16" | 190 | 230 | 300 | | | |
| 18" | 230 | 330 | 430 | | | |
| 20" | 270 | 390 | 510 | 660 | | |
| 22" | 320 | 450 | 640 | 800 | 940 | 1080 |
| 24" | 370 | 530 | 750 | 920 | 1100 | 1280 |
| 26" | 420 | 630 | 870 | 1100 | 1310 | 1510 |
| 28" | 500 | 750 | 1020 | 1240 | 1550 | 1810 |
| 30" | 610 | 900 | 1210 | 1520 | 1840 | 2150 |

Number of Board feet in tree _____.

**D.** BUILD A HOUSE

A 2000 square foot house needs 4000 board feet of lumber to frame and an additional 3000 to complete including cabinets. Calculate how many trees are needed to frame and build a 2000 sq. ft. house.

framing + completing = total board ft. needed.

_____ + _____ = _____

number of board ft. in tree ) Total Board Feet Needed ( Total trees cut down

_____ trees

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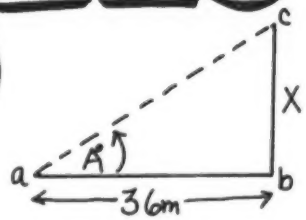
| m° | TAN. | m° | TAN. | m° | TAN. |
|---|---|---|---|---|---|
| 1° | .0175 | 31° | .6009 | 61° | 1.8040 |
| 2° | .0349 | 32° | .6249 | 62° | 1.8807 |
| 3° | .0524 | 33° | .6494 | 63° | 1.9626 |
| 4° | .0699 | 34° | .6745 | 64° | 2.0503 |
| 5° | .0875 | 35° | .7002 | 65° | 2.1445 |
| 6° | .1051 | 36° | .7265 | 66° | 2.2460 |
| 7° | .1228 | 37° | .7536 | 67° | 2.3559 |
| 8° | .1405 | 38° | .7813 | 68° | 2.4751 |
| 9° | .1584 | 39° | .8098 | 69° | 2.6051 |
| 10° | .1763 | 40° | .8391 | 70° | 2.7475 |
| 11° | .1944 | 41° | .8093 | 71° | 2.9042 |
| 12° | .2126 | 42° | .9004 | 72° | 3.0777 |
| 13° | .2309 | 43° | .9325 | 73° | 3.2709 |
| 14° | .2493 | 44° | .9657 | 74° | 3.4874 |
| 15° | .2679 | 45° | 1 | 75° | 3.7321 |
| 16° | .2867 | 46° | 1.0355 | 76° | 4.0108 |
| 17° | .3057 | 47° | 1.0724 | 77° | 4.3315 |
| 18° | .3249 | 48° | 1.1106 | 78° | 4.7046 |
| 19° | .3443 | 49° | 1.1504 | 79° | 5.1446 |
| 20° | .3640 | 50° | 1.1918 | 80° | 5.6713 |
| 21° | .3839 | 51° | 1.2349 | 81° | 6.3138 |
| 22° | .4040 | 52° | 1.2799 | 82° | 7.1154 |
| 23° | .4245 | 53° | 1.3270 | 83° | 8.1443 |
| 24° | .4452 | 54° | 1.3764 | 84° | 9.5144 |
| 25° | .4663 | 55° | 1.4281 | 85° | 11.4301 |
| 26° | .4877 | 56° | 1.4826 | 86° | 14.3007 |
| 27° | .5095 | 57° | 1.5399 | 87° | 19.0811 |
| 28° | .5317 | 58° | 1.6003 | 88° | 28.6363 |
| 29° | .5543 | 59° | 1.6643 | 89° | 57.2900 |
| 30° | .5774 | 60° | 1.7321 | 90° | UNDEFINED |

NAME _____

# TREES as a CROP




FORMULA: ab x Tangent A = X

ex. if ab = 36'
∠A = 35° ∴ TANGENT A = .7002
36 X .7002 = X
25.2072 = X ∴ The height is approximately 25m

| TREE | ANGLE° | TANGENT of ANGLE | X | DISTANCE FROM TREE | = | HEIGHT of TREE |
|---|---|---|---|---|---|---|
| 1. | _____ | _____ | X | _____ | = | _____ |
| 2. | _____ | _____ | X | _____ | = | _____ |
| 3. | _____ | _____ | X | _____ | = | _____ |
| 4. | _____ | _____ | X | _____ | = | _____ |
| 5. | _____ | _____ | X | _____ | = | _____ |

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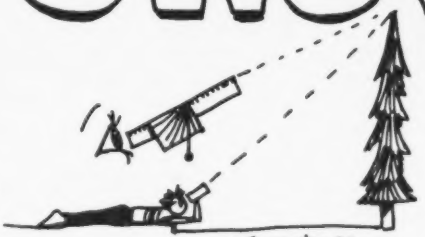
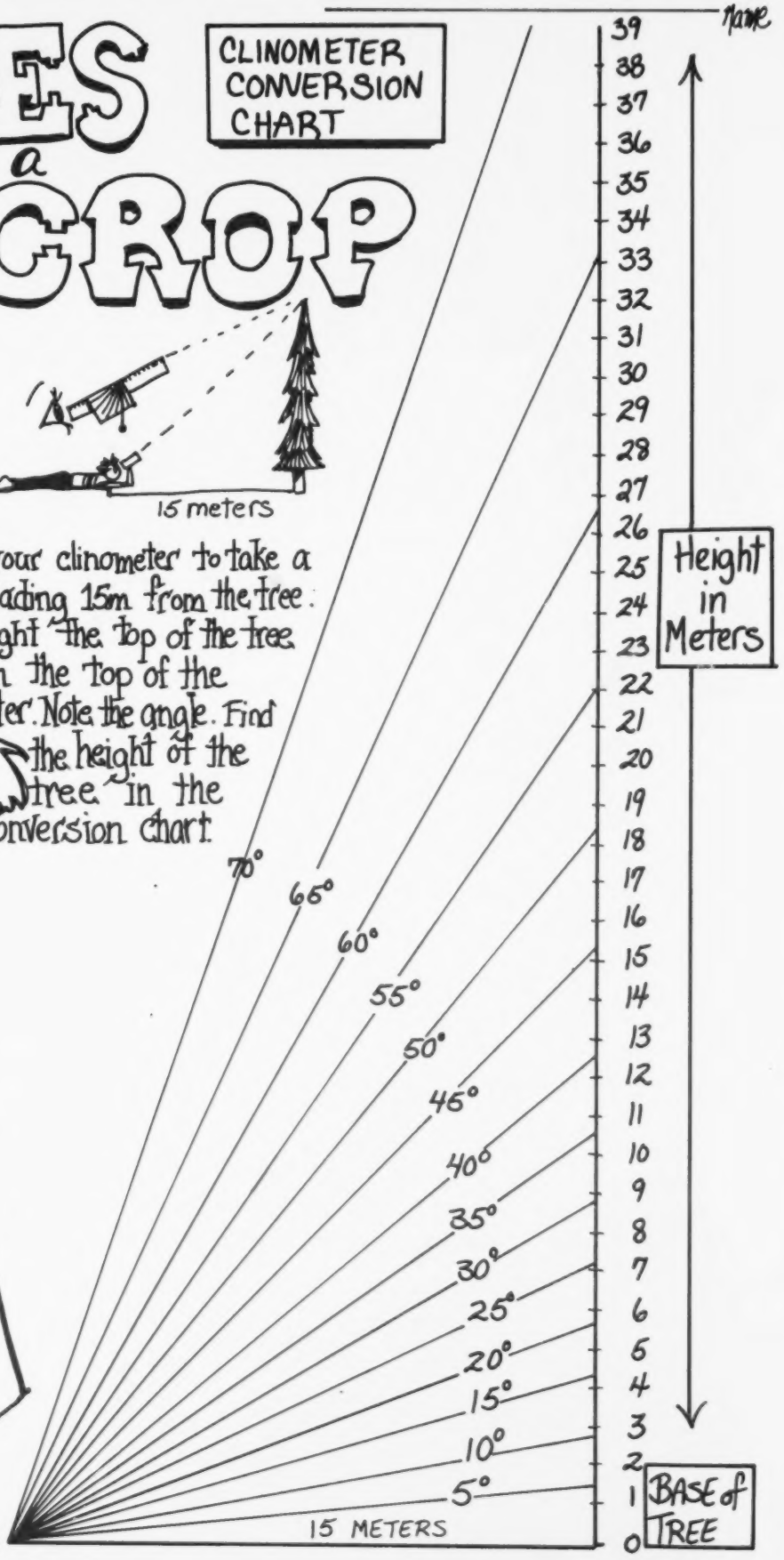
# TREES as a CROP

Name _____

## CLINOMETER CONVERSION CHART



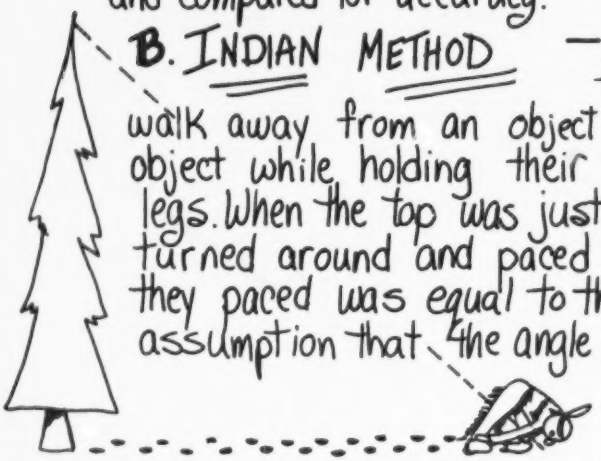

Use your clinometer to take a reading 15m from the tree. Sight the top of the tree with the top of the clinometer. Note the angle. Find the height of the tree in the conversion chart.



NAME

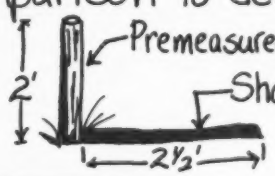
# TREES as a CROP

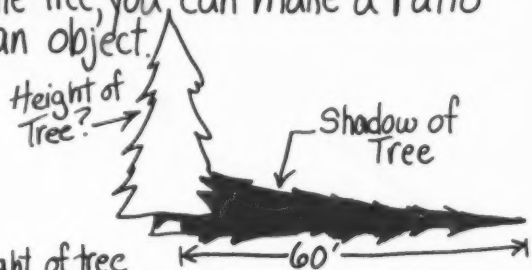
A. You may measure the height of a tree in several ways. The Biltmore stick is but one way. Below are 2 ways that may or may not be easy to use in the forest. A single tree could be measured by each method and compared for accuracy.



B. INDIAN METHOD — To measure height, it has been recorded that some groups of Indians would walk away from an object until they could sight the top of the object while holding their ankles and viewing through their legs. When the top was just visible through the crotch, they turned around and paced the distance back to the object. The distance they paced was equal to the height of the object. This is based on the assumption that the angle formed by this sighting is equal to 45°.

C. SHADOW RATIO - In an open field or area where you can measure the shadow of the tree, you can make a ratio comparison to determine the height of an object.




D. Find the height of 5 trees using the 3 different methods of finding heights. How close were your calculations?

$$\frac{\text{height of stick}}{\text{shadow of stick}} = \frac{2'}{2\frac{1}{2}'} = \frac{N}{60'} \quad \frac{\text{height of tree}}{\text{shadow of tree}}$$

$$2\tfrac{1}{2}N = 120$$

$$N = 48 \quad \therefore \text{height of the tree is 48 feet}$$

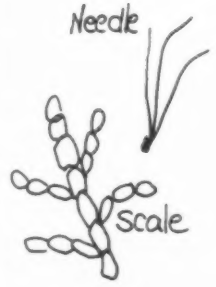
| TREE | CLINOMETER | INDIAN SIGHTING | SHADOW STICK | POSSIBLE EXPLANATION OF VARIATION |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

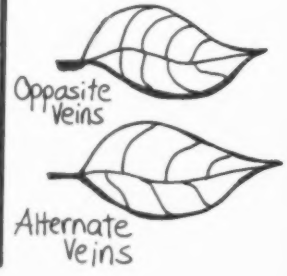
# NATURE'S FOOD FACTORIES

NAME

## Leaf Classification Chart

| Name of Plant or Tree | | | | | | | |
|---|---|---|---|---|---|---|---|
| Leaf Shape | | | | | | | |
| # of Primary Veins | | | | | | | |
| # of Secondary Veins | | | | | | | |
| Length of Leaf | | | | | | | |
| Width of Leaf | | | | | | | |
| Area of Leaf | | | | | | | |
| # of Points | | | | | | | |
| Leaf Margin | | | | | | | |
| Other Observations | | | | | | | |
| SKetch of Leaf | | | | | | | |

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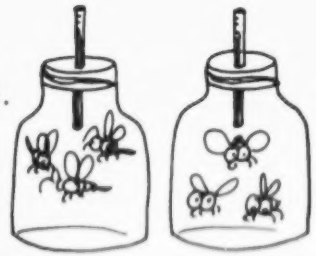
# FLY BY HEAT

OBSERVER _____

How does temperature affect insect movements?

**A.** Poke a hole in the lid of two 1 qt. jars and insert a thermometer in each.



| Start Temp. + | Record Temp. | Time Bee Jar | Time Fly Jar | Bee Movement Description | Fly Movement Description | General Observations | |
|---|---|---|---|---|---|---|---|
| | | | | | | Bee | Fly |
| X +18° | | | | | | | |
| X +16° | | | | | | | |
| X +14° | | | | | | | |
| X +12° | | | | | | | |
| X +10° | | | | | | | |
| X +8° | | | | | | | |
| X +6° | | | | | | | |
| X +4° | | | | | | | |
| X +2° | | | | | | | |
| X | | | | | | | |

START ↗

**B.** Put several bees in one jar and several flies in the other.

**C.** Insert both jars in the refrigerator until insects have ceased all movement.

**D.** Remove jars and record temperatures.

**E.** Shine the heat lamp on the jars and continue recording temperatures.

**F.** Record your observations, when they twitch, walk & fly.

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# NOW YOU SEE IT, NOW YOU DON'T

## ANIMAL CAMOUFLAGE

OBSERVER _____

| Color of Disks | Yellow Background | |
|---|---|---|
| | # Counted | % Counted |
| YELLOW | | |
| GREEN | | |
| BLACK | | |
| PINK | | |

| Color of Disks | Black Background | |
|---|---|---|
| | # Counted | % Counted |
| BLACK | | |
| PINK | | |
| YELLOW | | |
| GREEN | | |

| Color of Disks | Green Background | |
|---|---|---|
| | # Counted | % Counted |
| GREEN | | |
| BLACK | | |
| PINK | | |
| YELLOW | | |

| Color of Disks | Pink Background | |
|---|---|---|
| | # Counted | % Counted |
| PINK | | |
| YELLOW | | |
| GREEN | | |
| BLACK | | |

1. What happened?
2. Why do you think this happened?
3. How might this relate to the survival of species in our world?

Observer
(counts silently as many disks as he is able to see)
Safety Person
(insures the safety of the counter)
2 meters
Disks
Railroad Board
Timer
(times for 1 sec. and records the number of prey counted by observer)

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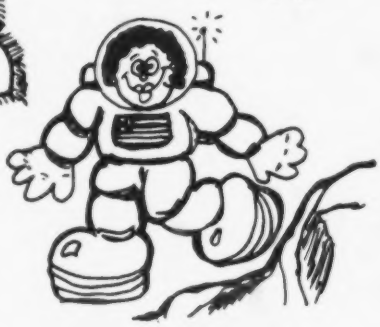
# HUMAN FUR

NAME _____



## Predictions and Results

What type of body coverings make the best insulators of body heat?

Make your prediction by placing the cans in the order you think they will test out. The first should be the best insulator, the last should be the worst.

| Predictions (before experiment) | | Actual (after results) | |
|---|---|---|---|
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |
| Can | | Can | |

Explain why you ordered the cans in this way for your experiment. _____

_____

_____

_____

_____

_____

_____

_____

_____

Which material was the best insulator? _____

_____.

Which material was the best conductor (worst insulator)? _____

_____.

What type of clothing should be worn in a really cold environment? _____

_____

_____.



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What type of body coverings make the best insulators of body heat?

# HUMAN FUR

NAME _____

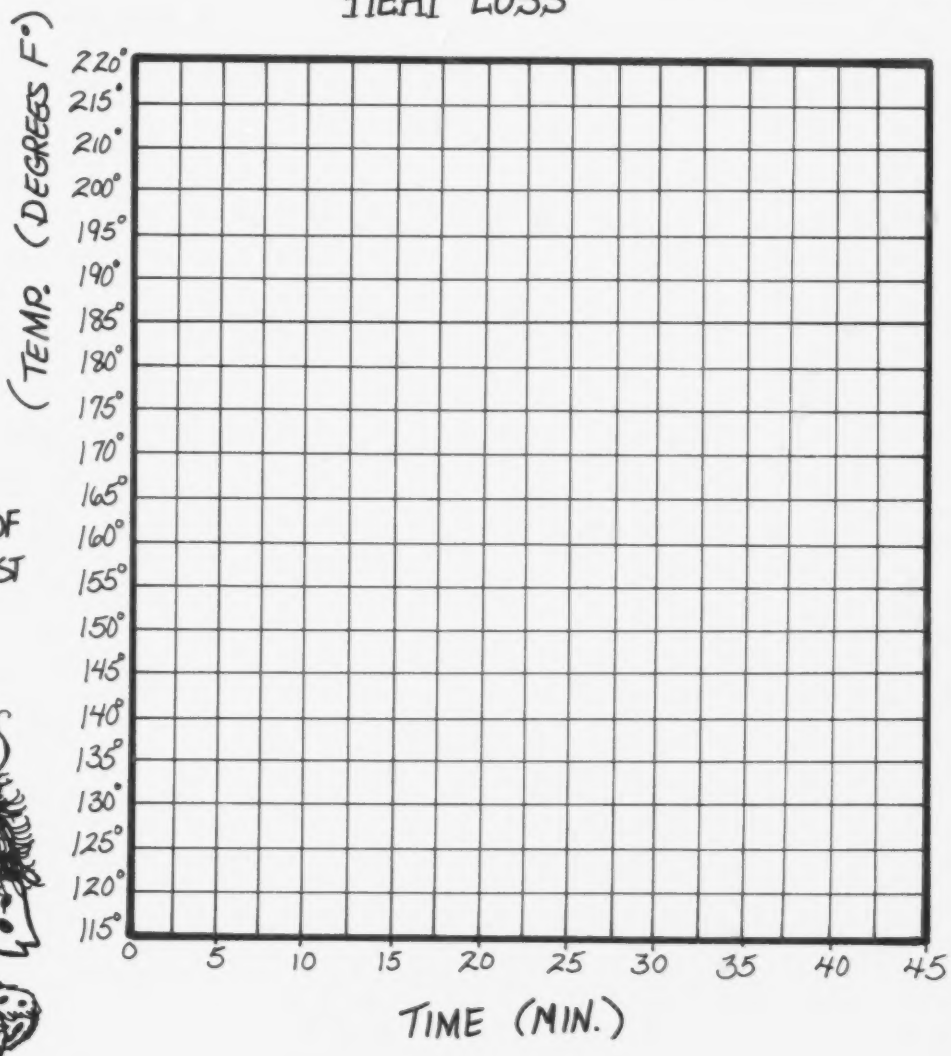
TYPE INSULATOR _____

1. Fill your group's can with 400ml of boiling water and cover the can.
2. Quickly insert the thermometer.
3. Record the initial temperature on the chart. Take readings every 5 min. for 40 min. Record all readings on the chart.
4. Graph results to see if heat loss was constant.

| TIME | TEMPERATURE |
|---|---|
| 0 min. | ° |
| 5 | ° |
| 10 | ° |
| 15 | ° |
| 20 | ° |
| 25 | ° |
| 30 | ° |
| 35 | ° |
| 40 | ° |

TOTAL NUMBER OF DEGREES LOST

## HEAT LOSS

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OBSERVER _____

# INSECT LAWN JUMPERS

| | PREDICTIONS | DATA | OBSERVATIONS |
|---|---|---|---|
| COLOR, DESCRIPTION WHERE FOUND | | | |
| LENGTH | | | |
| WEIGHT | | | |
| # OF EYES | | | |
| # OF LEGS | | | |
| # OF BODY SECTIONS | | | |
| # OF WINGS | | | |
| LENGTH OF HEAD | | | |
| LENGTH OF THORAX | | | |
| LENGTH OF ABDOMEN | | | |
| LENGTH OF HIND LEG | | | |
| LENGTH OF FRONT LEG | | | |
| LENGTH OF LONGEST LEAP | | | |
| LENGTH OF LONGEST FLIGHT | | | |

SKETCH YOUR GRASSHOPPER HERE

How far could you jump, if you had your grasshoppers jumping ability?

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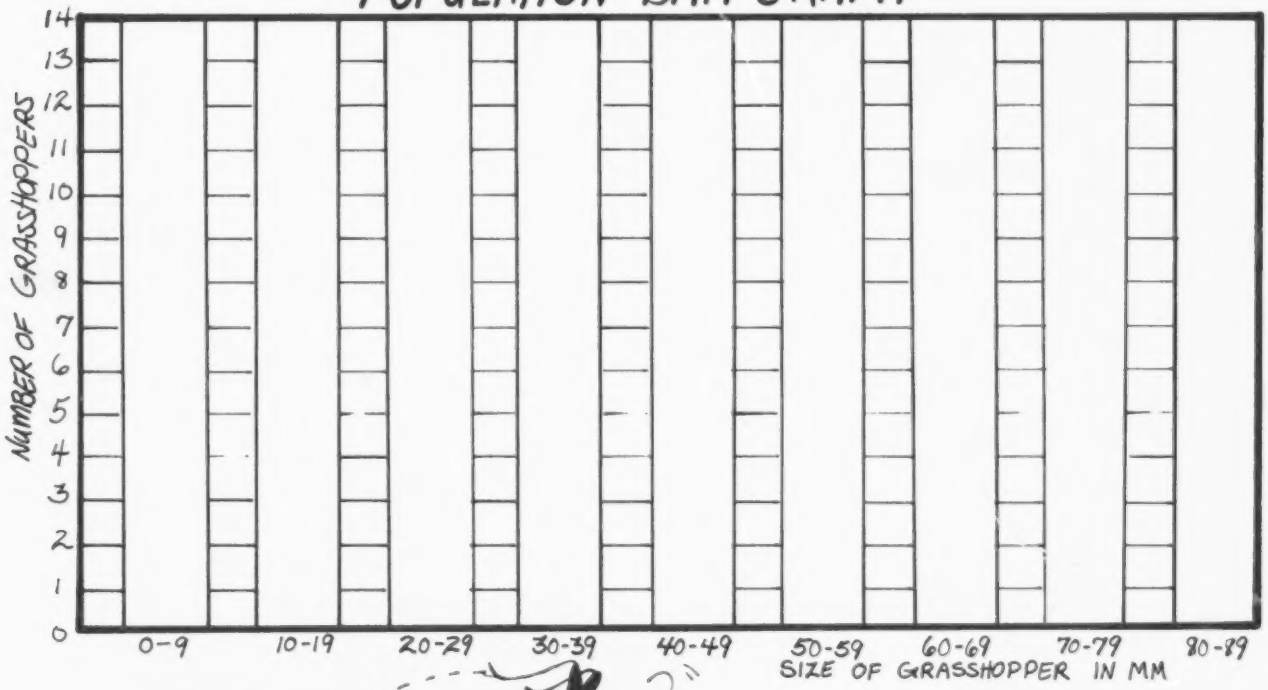
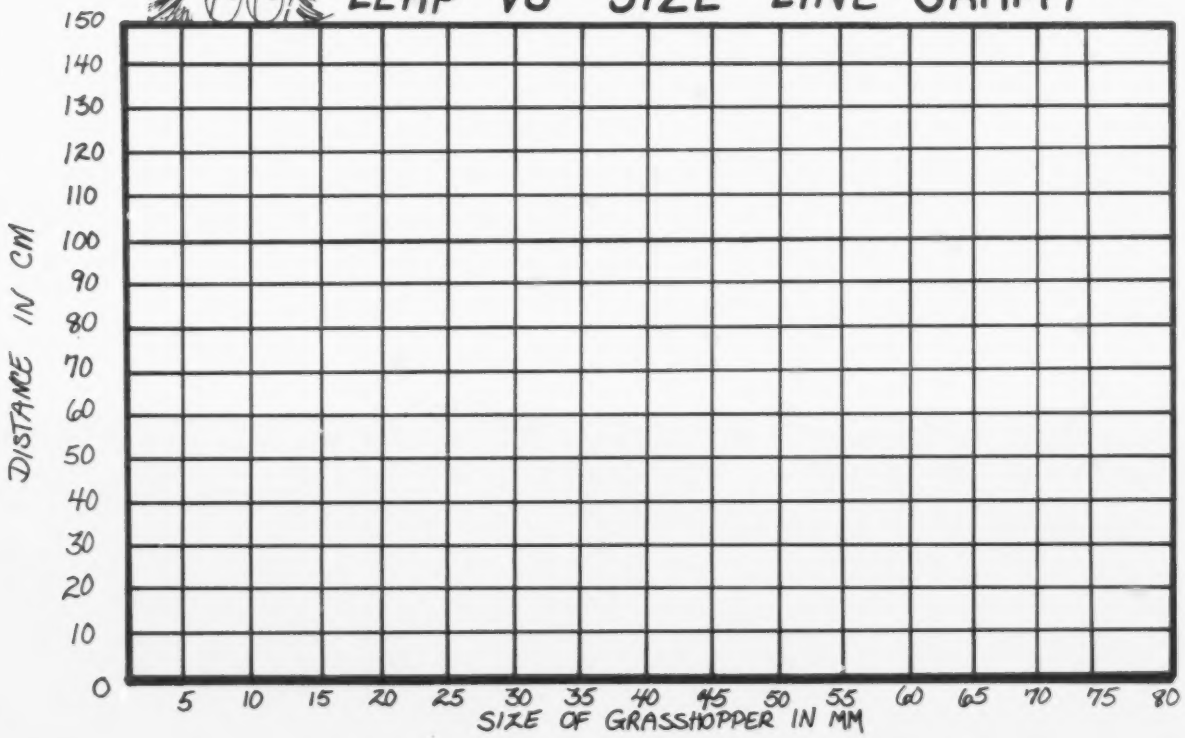
OBSERVER

# INSECT LAWN JUMPERS

## POPULATION BAR GRAPH



## LEAP VS SIZE LINE GRAPH



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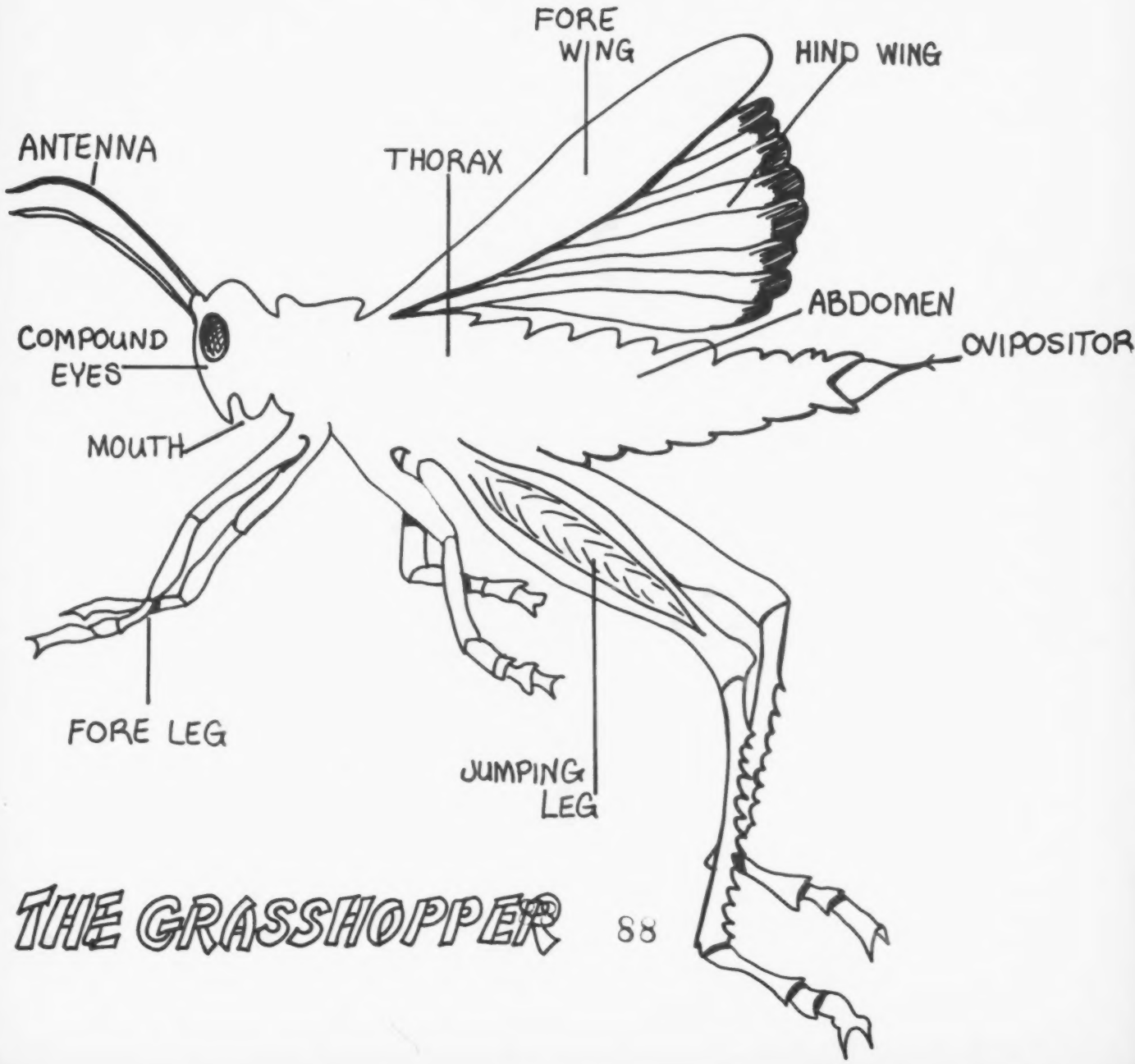


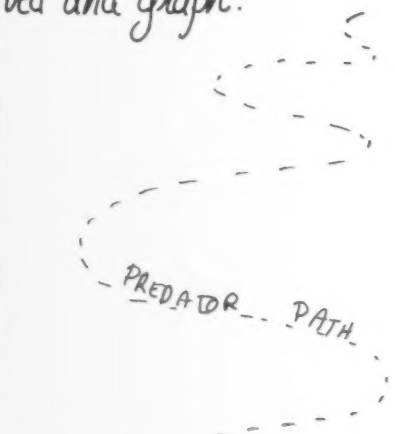

# THE GRASSHOPPER

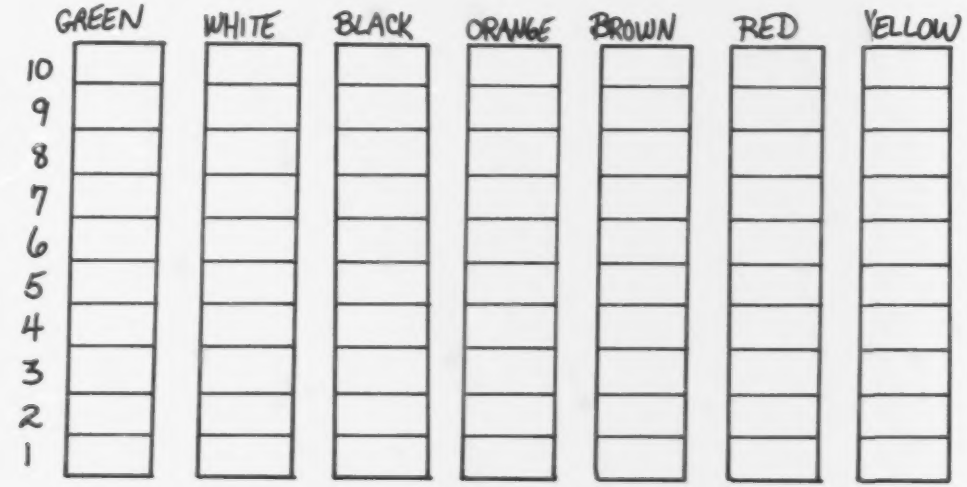
# PREDATOR vs. PREY

PREDATOR _____

Hide your animals (colored pipe cleaners) in a marked-off area. Students are now transformed into "predators" who have to find their "prey". Predators have 30 seconds to find all the food they can and bring it back to their starting point. Record how many were returned to find how much of the "prey" survived. Find the average survived and graph.

| COLORS | GREEN | WHITE | BLACK | ORANGE | BROWN | RED | YELLOW |
|---|---|---|---|---|---|---|---|
| # Began with | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| TRIAL 1 # Returned | | | | | | | |
| TRIAL 1 # Survived (difference) | | | | | | | |
| TRIAL 2 # Returned | | | | | | | |
| TRIAL 2 # Survived | | | | | | | |
| TRIAL 3 # Returned | | | | | | | |
| TRIAL 3 # Survived | | | | | | | |
| AVERAGE # SURVIVED | | | | | | | |



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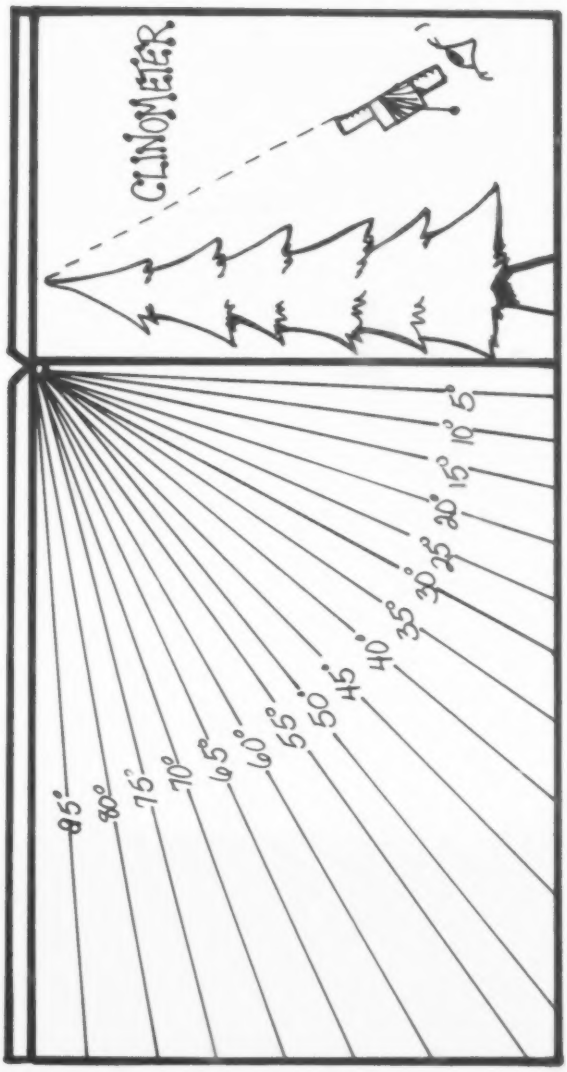
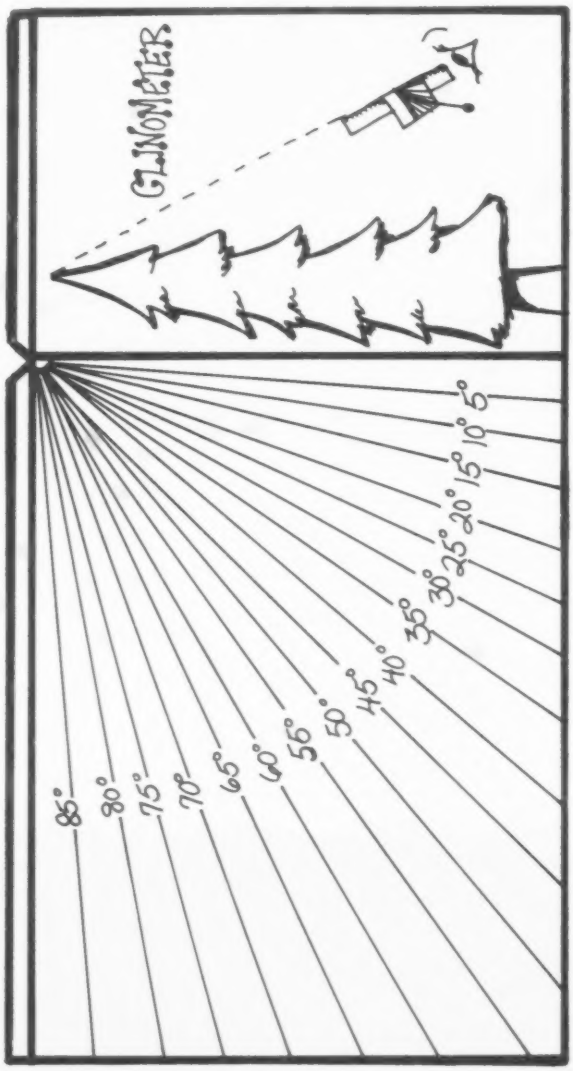
CONSTRUCTING YOUR CLINOMETER

1. You will need a copy of the clinometer pattern, a 20 cm piece of thread, a washer, a ruler and scotch tape to construct your clinometer.
2. With a pair of scissors, cut down to the white dot on the clinometer (the vertex of the angles).
3. Lay one end of the thread into the cut so that 2 cm of thread hangs on the backside of the clinometer.
4. Tape that end of the thread securely to the back.
5. Tie a washer to the other end and make sure the thread swings freely from the vertex.
6. To provide a sighting plane, tape the clinometer to a ruler or a large straw



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